ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XLII. No. 18.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....281, 295
The Wurdemann Automatic Dividing Engine (illustrated) 282
Practical Microscopic Analysis for Use in Steel Works (illustrated) 282
Bascule Bridges for the Chicago River (illustrated) 286
The Convention Hall at Kansas City, Mo. (with two-page plate) 287
Pig Iron Fractures and Their Value in Foundry Practice 291
The Lanston Type-Setting and Casting Machine (illustrated) 292
Electric Motors for Driving Auxiliary Machinery on War Vessels 294
Notes from the Engineering Schools..... 294
Book Reviews. 296
EDITORIAL NOTES 288
President James J. Hill on "Rail vs. Water Transportation"—Opposition to the Opening of the Chicago Drainage Channel—Controversies Over the Furnishing of Water for Fire Protection—The Microscopic Analysis of Steel—Pig-Iron Fractures—Current Absurdities Respecting the Isthmian Canal.
EDITORIAL:
Motor-Vehicles in the Stock Market..... 289
LETTERS TO THE EDITOR 290
A Novel Footway Suspension Bridge (illustrated)—The Organization of Railway Engineering and Maintenance-of-Way Departments—A Sure Cure for the Jigger Pest of South America—Relative Consumption of Water per Capita in Washington and Philadelphia (illustrated).

THE PRELIMINARY PLANS FOR THE STORAGE reservoir for the new water supply of Jersey City provide for a dam 100 ft. in height, from the present bed of the Rockaway River to the full water level of the reservoir. The top of the waste way would be 302.42 ft. above high water at Jersey City. The dam would flood 852 acres and give an available storage of 7,190,000,000 gallons. This is all on the basis of a daily supply of 50,000,000 gallons.. If the city demanded an increase to 70,000,000 gallons the dam would be raised to an elevation of 320.98 ft., or 18.56 ft., giving a total available storage capacity of 12,660,000,000 gallons. As now proposed, the supply conduit will consist, first, of about two miles of tunnel and 3½ miles of masonry aqueduct, both on the hydraulic grade, and capable of delivering 70,000,000 gallons a day; and, next, of 17 miles of steel pipe, having a daily capacity of 50,000,000 gallons. Some three miles of railway track will be used in constructing the dam, of which about half has been laid. A granite quarry has also been developed. The above information has been taken from a formal communication addressed by the Jersey City Water Supply Co., the contractors for the new works, to Mr. Garwood Ferris, Engineer-in-Charge of the new supply in behalf of Jersey City. In case Mr. Ferris approves the location selected, the company states that it will proceed with the preparation of detailed plans. Mr. P. H. Flynn, 189 Montague St., Brooklyn, N. Y., is President of the Jersey City Water Supply Co.

WATER PURIFICATION EXPERIMENTS AT ST. Louis are proposed by a draft of an ordinance just submitted to the Board of Public Improvements. The ordinance, to be effective, must pass the board named and be approved by the Municipal Assembly.

A PURE WATER SUPPLY is desired for the towns on the west shore of Lake Michigan, between Milwaukee and Chicago, and a meeting of representatives of several of these towns was held recently at Highland Park. It is considered that water all along this part of the shore is badly contaminated, not by the towns there located, but mainly by the sewage discharged from Milwaukee. Little definite information was given, however, but other meetings are to be held, and if the necessary funds can be provided the State Board of Health will make an examination of the water supply all along the shore. At present, the Board's appropriation is nearly exhausted. Dr. J. A. Egan, of the State Board of Health, and Mr. Jacob A. Harman, M. Am. Soc. C. E., engineer to the Board, were present at the meeting.

AN INVERTED SIPHON supported on a timber trestle forms a distinctive feature of the 9-mile flume which conveys water to the works of the Twin Springs Placer Co., in Idaho. This siphon takes water from the flume terminating on one side of the Boise River and discharges it into the flume beginning on the opposite side of the river. The difference in elevation between the siphons intake and discharge is 35 ft., and the total length of the siphon is 1,780 ft. The bottom of the siphon is supported on a wooden bridge 110 ft. above the surface of the stream below. At the intake the siphon is 6 ft. in diameter, but this decreases to 4 ft., which is the diameter of the remainder of the siphon. The upper sections of the pipe on each side of the stream are ⅝-in. steel, the middle sections ⅛-in. steel and the bottom portion ⅝-in. steel. The elbows are ¼-in. steel. There are four expansion joints in the siphon. Mr. J. Bouse, of San Francisco, Cal., designed the siphon. The open flume in which this siphon forms a link is 6 ft. 2 ins. wide, 7 ft. high, and carries 5 ft. depth of water.

A NEW SEWERAGE SYSTEM FOR SAN FRANCISCO has been recommended by a board of engineers comprising Messrs. Marsden Manson, M. Am. Soc. C. E.; C. E. Grunsky, M. Am. Soc C. E., and Chas. S. Tilton, City and County Surveyor. Mr. Rudolph Hering, M. Am. Soc. C. E., acted as consulting engineer to the commission. The proposed plan includes a comprehensive sewerage system for the city and county, based on a future population of 1,000,000. The present sewers, most of which have been built in the most haphazard and makeshift fashion, would be utilized where possible, but apparently for storm water only, in some important sections of the city. Where the storm sewers were so utilized, as well as where pumping was necessary and natural water courses or outlets were available, the separate system is recommended. The crude sewage would be discharged into the bay, which is considered capable of receiving the sewage for a long time to come, without any objectionable results. The estimated cost of the complete system, as recommended, is $4,600,000. As we understand it, no steps have been taken to provide money to carry out this plan, or any part of it.

OPEN SEPTIC TANKS are being tried at Leeds, Eng., in connection with extensive experiments on the treatment of sewage now being carried on by the city. The Lord Mayor of Leeds, in moving that the city council make a further appropriation of $25,000 for these experiments, said that the open tanks "gave results very similar * * * to those which Mr. Cameron himself had obtained." Besides open and closed septic tanks, various systems of filtration are being tried at Leeds. The additional appropriation was granted. About one-fourth of it will go to make good the excess of expenditures over the first appropriation. The gravity of the situation at Leeds can be better appreciated when it is stated that the chemical precipitation works are inadequate, although $140,000 was spent recently for extensions; that 300 (long) tons of wet sludge are produced daily, for which no means of disposal have been provided except the very slow process of drying by spreading on land; that while some treatment of the effluent from the precipitation works is imperative, there appears to be no land suitable for the purpose within 20 miles; and that the cost of land at that distance, 1,000 acres being required, is almost prohibitive.

THE SINKING OF A TIMBER CRIB by the simple process of building it on barges and sliding it over the stern as fast as new lengths were constructed, was successfully accomplished by the engineers of the Chicago Drainage Canal in their work of carrying the channel through the state dam at Joliet, Ill. The barges used were 60 x 16 ft. and the crib was built up about 2 ft. high on them, and then they were forced ahead letting the crib tail out behind to be built full height by men on rafts, who followed in the wake of the barges. This proved a very rapid and effective mode of construction, and the crib was tailed off at the rate of 150 to 200 ft. per day. At intervals of 10 ft. there were pockets 5 ft. long, with bottoms, in which the rock for sinking was placed; the rest of the spaces had no bottoms. As soon as the crib was sunk it was filled with earth. A somewhat similar method adopted for sinking a submerged water main was described in our issue of Oct. 12, 1899.

THE ORDINANCE PROVIDING FOR ELECTRICAL subways in San Francisco, noted in our issue of Aug. 3, and since passed by the supervisors and approved by the mayor, divides the city into four districts, and makes it unlawful to erect or use overhead wires on the streets or alleys of the city after dates ranging from early in 1900 to July 1, 1902, according to the location of the districts. The ordinance applies to all wires used for transmitting electricity for electric light, heat, power, telegraph, telephone or other electric service, except that it permits certain wires to cross single streets and exempts wires used exclusively for street railway purposes. If the poles and wires are not removed by the dates specified they may be taken down by the city and the companies involved are liable to heavy fines. The ordinance in question was framed by the Merchants' Association of San Francisco, and when presented by it to the Board of Supervisors was accompanied by an agreement to comply with its provisions by all but one of the electrical companies in the city having overhead wires in the districts affected. We are indebted to Mr. L. M. King, Superintendent of the Merchants' Association, for a copy of the ordinance.

A TRACK ELEVATION ORDINANCE of considerable importance has been passed by the Chicago city council, which provides for the following work: Pittsburg, Fort Wayne & Chicago Ry., 55th St. north to 21st St.; Chicago & Western Indiana R. R., 72d St. north to 21st St.; Chicago & Grand Trunk Ry., Wallace St. southwest to Morgan St.; Union Stockyards & Transit Co., Wallace St. southwest to 48th St. There will be about 50 subways, most of them 40 ft. wide. The cost of the entire work will be about $2,500,000, and the bulk of the work will probably be done next year. This is probably the last of the important ordinances of this kind, as the work not covered by existing ordinances will consist mainly of small sections and of extensions of work already done.

COMPRESSED AIR STREET CARS on the Hardie system are used on the North Clark St. cable line, in Chicago, during the night hours when the cable plant is shut down, from 12.45 to 5.45 a. m., and 12.45 to 7.45 a. m. on Sundays. Since May 30 the cars have run 6,487 miles and have carried 71,155 cash passengers, or 77 passengers for each round trip of 7 miles. The compressor plant is in the cable power house at Clark and Elm Sts., and has been in actual operation for 443 hours, while the cars have been in actual operation for 398½ hours. Four-wheel cars are used, which are very similar to the cars which have been in service for about a year on 125th St., New York city. The system is being introduced in Chicago by the Compressed Air Motor Co.; President, Henry D. Cooke; Engineer, Robert Hardie.

THE CHICAGO RIVER BRIDGES, or many of them, are in defective condition, as recently noted in our columns, but the city has no money for repairs or renewals, and has apparently no means of providing any. At a meeting between city officials and business men whose interests have been affected by the closing of the defective Division St. bridge, the only method of relief which received any encouragement from the city was that the business interests should advance the money for a new structure, the city to pay 6% per annum for the loan.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-on collision between two freight trains on the Baltimore & Ohio R. R. at Bellaire, O., on Oct. 27. The collision occurred in a fog, and was the result of neglect of orders in regard to the meeting point. One man was killed and both engines and 34 cars were demolished.

THE FERRYBOAT "CHICAGO," plying between the Jersey City and Cortlandt St. (New York) stations of the Pennsylvania R. R., was run into and sunk by the coasting steamer "City of Augusta," on Oct. 31. The collision occurred near the Cortlandt St. slip, where the ferryboat sunk in 35 ft. of water. The driver of a mail wagon was drowned, but it is believed that all the other passengers escaped.

AN ELEVATOR ACCIDENT occurred in Chicago, Oct. 24, resulting in the death of one person and the serious injury of three others. The accident occurred in the Warren Springer Building, 231 Canal St., which is six stories high and is occupied by small manufacturing establishments. The cable broke or tore from the eye fastening on the car, and the car fell the whole depth of the building, having apparently no safety appliances of any value. It is said to have been a second-hand machine, inefficient and notoriously dangerous, the tenants of the building being almost afraid to use it. Chicago has a number of cases of this kind, according to the statements of the Building Department, as stated in our issue of April 27. According to the accident records of the Police Department this building has had five elevator falls since 1891, this last being the most serious.

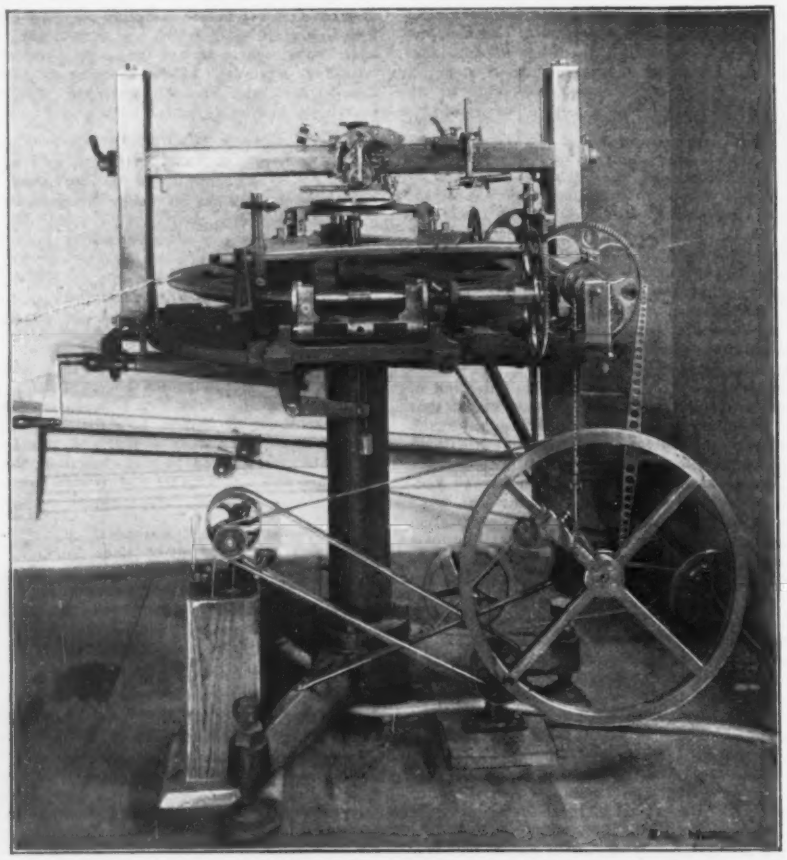
AN ELECTRIC RACK-RAILWAY at Laon, France, has been built to connect the station of the four lines of railway reaching this town with an elevated plateau containing the larger part of the population, lying about 672 ft. above the station. An Abt rack-rail track, operated by an overhead electric system was adopted with 1-m., or 3.28-ft. gage. The electric power is furnished from the power station for electric lighting, and ordinary street cars are used seating 40 passengers, or 30 with baggage. The whole line is only 1¼ miles long, and it was opened to traffic on July 9, 1899. The first cost of the line, including current transformers, was nearly $90,000; but this cost covers a considerable amount of expensive masonry construction. This line is illustrated and described in detail in the "Revue Generale des Chemins de Fer," for October, 1899.

THE ALUMINUM FEED WIRES for the new Northwestern Elevated Ry., in Chicago, will require 150,000 lbs. of that metal for their manufacture. The feeders will be placed in a wooden box, or trough, covered by the board walk between the double tracks, and will be supported on vitrified clay blocks placed about 9 ft. apart, and designed with an umbrella drip.

THE WURDEMANN AUTOMATIC DIVIDING ENGINE.

By C. L. Berger.†

The advance made in astronomy, and in geodetic work, during the last two centuries, has been made possible by the perfection of the telescope, the fine and accurate graduation of the circle, and the skill applied in the combination of metals in the construction of instruments of precision. The demands of the users of instruments have taxed the ingenuity of the makers, constantly requiring greater perfection. Graham and Bird in the last century, and Ramsden, Troughton, Repsold and Gambey, in the present century, have become names as familiar in scientific circles as those of the celebrated scientists who have used their instruments; and their fame was chiefly derived from the care and skill exercised in dividing a circle into degrees, minutes and seconds.



WURDEMANN AUTOMATIC DIVIDING ENGINE IN THE SHOPS OF C. L. BERGER & SONS, BOSTON, MASS.

It is only within recent years that machinery has been constructed that will do this graduation work with almost absolute accuracy, and at the same time working automatically. This machinery is so accurately constructed, requiring years of patient labor to perfect, that to-day there are less than a dozen first-class dividing engines in America.

An engine designed and constructed by Mr. William Wurdemann, of Washington, for automatically graduating the circles of astronomical and scientific instruments, and theodolites, has been added to the equipment of the works of Messrs. C. L. Berger & Sons, of Boston, and is worthy of special notice, not only for novel features in the construction, but for its remarkable accuracy.

On the main iron circle of the engine is inlaid a silver ring graduated to 10 minutes of arc, a space corresponding to one of the teeth on the edge of the circle. This graduation can be controlled by four micrometer-microscopes for verification of the work of the engine. The circle is moved by a tangent screw gearing, one revolution of which moves the main circle 10 minutes of arc. A drum head on the tangent screw is graduated into 120 spaces, which permits the movement of the circle in arcs of 5 seconds. Two driving screws are employed, geared together so as to move in the same direction and at the same speed, and arranged on opposite sides of the circle. Driving the circle by two screws tends to divide and equalize any errors or differences arising from slight imperfections in the gear teeth or screws. In consequence of the greater contact surface between the moving screws and the engaging teeth of the screw there is less pressure and friction on the part of the circle engaged by the screws, and the bearing is relieved of side pressure.

One screw can be used for ordinary work, but for finer graduations, to eliminate all errors of graduation and eccentricity of the main circle, both tangent screws are employed. There is a plain coarse graduation on the iron circle, corresponding to that of the silver plate, whereby the circle or vernier to be graduated can be set by an adjustable index. With this engine, circles can be graduated in spaces of degrees, and 30′, 20′, 15′, 10′, 5′ or 2′; or a circle can be divided on the centessimal system, i. e., into 400°, each of 100 minutes; each minute of 100 seconds. Circles divided on this engine are either read by micrometer-microscopes to single seconds of arcs, or to 5″, 10″, 15″, 20″, or 30″, according to the fineness of the graduations, by the use of verniers; or by a special vernier to hundredths of a degree, instead of minutes. On top of the graduating circle is placed the centering apparatus, whereon the circle to be graduated can be mounted and truly centered and clamped, so that each circle will truly coincide with the vertical axis of the dividing engine. This is accomplished by a spirit level reading to single seconds of arc. To graduate a circle to half-degrees requires about 3 hours; if a finer graduation is required a correspondingly longer time is necessary. The whole engine is so arranged that it works automatically. It is driven by an electric motor and requires no personal attention when once started. The Messrs. Berger prefer to graduate their finest circles at night with the lights turned low. The engine stops automatically when the graduation of the circle is completed.

The axis of the circle is of novel shape; it is a perfect cylinder where it is attached to the circle, and ends below in a hard steel cone which bears the weight. The effect of this long cylindrical axis is that the circle turns with uniform ease under all conditions of temperature. The axis enters a cast-iron column, into which its upper end is perfectly fitted, so as to turn easily without any possible shake. The column is supported on a cast-iron tripod with leveling screws that step into iron cups. The whole engine is made entirely of iron and steel. The most important parts are hardened. The circle and its bearings are of hard cast iron, a dense metal, with a small coefficient of expansion by heat which reduces to a minimum the variations due to changes in temperature.

Although the circle of the engine is but 30 ins. diameter, a meridian instrument circle 45 ins. diameter has been graduated upon it to two-minute spaces, making 10,800 lines, with a very satisfactory result, the probable error not reaching 2 seconds of arc, a degree of accuracy never before attained, according to the maker.

The fine work of the engine has been substantiated by the close results obtained in the field by an expert observer measuring an angle with one of the smaller transits, a 6¼-in. instrument graduated to 30″, taken at random from those in the shops. Other instruments subjected to the same test have given like results.

The graduation of a 6-in. circle made on the Wurdemann engine by the firm for the use of a city engineer was tested by Mr. John N. McClintock, A. M. C. E., an experienced observer, under conditions similar to those the instrument will be ordinarily subjected to, i. e., set up in the heart of the city, on the ground, with the objects observed within 1,000 ft. of the station occupied:

	A vernier.	B vernier.	Mean angle.	Result. Correction.
Spear	360° 00′ 00″	0′ 00″		
State House	140° 25′ 50″			
Direct 6	122° 31′ 00″	31′ 00″	140° 25′ 10″	
Reverse 6	245° 02′ 30″	2′ 30″	140° 25′ 15″	
			140° 25′ 12.5″	+3″
State House:				
Reverse 6	122° 30′ 30″	30′ 30″	219° 34′ 40″	
Spear: Direct 6	359° 58′ 50″	58′ 50″	219° 34′ 43″	
			219° 34′ 41.5″	+3″

This observation was made at noon of a warm clear day, and the results are as satisfactory as could be expected under the circumstances.

In a more careful test, with the instrument occupying a station used by him in the triangulation of Boston, Mr. McClintock measured three angles—with 6 direct and 6 reverse sights on each, and his "corrections" were + 0.1, + 0.1 and + 0.2, respectively; or + 0.4 for a total angle of 359°, 59′, 59.6″.

†9 Province Court, Boston, Mass.

PRACTICAL MICROSCOPIC ANALYSIS FOR USE IN STEEL WORKS.*

By C. H. Ridsdale, F. I. C., F. C. S.†

Introductory Remarks.

The structure and microscopical examination of steel is a subject on which a good deal has been said during the last few years, and it may seem to many of you that an apology is needed for again bringing it forward, but I must plead in extenuation: (1), that the subject, being comparatively new, is perhaps entitled in its earlier stages to have a good deal of attention drawn to it; and (2), that, valuable and interesting as many of the communications and discussions have been, I trust I may not be misunderstood if I say that they have been so chiefly either from a general, or else from a purely scientific point of view. For instance, although the question of the various hardening theories has concentrated interest on subjects, the study of which must lead to practical results, to many members it may not seem of immediate practical value, and no doubt whilst the numerous papers and discussions on this and other questions have been going on, the thought has arisen in their minds, Of what practical value is the microscope to us to-day?

The present paper will, I trust, be found to be essentially of a practical nature, and in some degree to answer the above question (or to be the means of eliciting an answer to it), as it will be looked at mainly from the steel makers' and users' point of view. The exact position may perhaps be shown more clearly by, in the first place, quoting a little from our own experience, and this may be of benefit to others who feel themselves similarly situated.

Although we had used the microscope in our laboratory

*Abstract of a paper read before the Iron and Steel Institute of Great Britain.

†Guisborough, Yorkshire, England.

for some years, it had, so far as steel samples were concerned, been chiefly in connection with what Mr. Osmond terms "pathological" questions, such as to verify soundness, or to examine unusual fractures of test pieces, and, on the whole, in a desultory way. During the last two or three years, however, in view of the growing interest in microscopy, and feeling that we must be thoroughly up to date in this matter, the question was presented strongly to my mind whether it was not desirable to go more fully into the microscopic examination of steel. One thing was certain, we could not afford to follow up matters of purely scientific interest on the off-chance of their ultimately leading to valuable results, however alluring that course might be. Works laboratories are not kept up for such purposes, but to yield results of immediate practical value. If the microscope was going to do this, it was a duty to the firm to press it into service; if not, it had no place with us for regular daily use, as, if the work was to be undertaken systematically, and to any material extent, it seemed likely it would involve an appreciable amount of labor and cost, and therefore the utility must be commensurate with this.

It did not seem that this would be the case, or indeed that any useful purpose would be gained by merely following up researches on the lines hitherto followed, or preparing specimens which were simply interesting from a scientific point of view. On the whole, it seemed likely that it could be turned to account, but then the question arose: how was it to be made of practical use to us; in short, what should we examine for? The microscopic analysis of steel was a new thing, and there was no recognized system of tests. All the data had to be got, and the system devised. In order to settle this question, a preliminary investigation up to a certain point seemed not only justified, but to be the only course to see if the daily use of the microscope was feasible on practical lines.

As to the direction in which microscopy might be made useful, suppose, for instance, a case arose in which steel at some stage, while it was being worked up, differed from its normal behavior, and the chemical analysis showed nothing to account for the abnormal results obtained. Now, we most of us have our own ideas as to the causes of any behavior out of the common which material exhibits, and there are several directions in such cases in which it seemed probable that microscopy might afford light to verify or disprove the correctness of these ideas; but there arose another difficulty. It might be quite possible to satisfy one's self, or to prepare a record of researches which would be listened to indulgently by the members of some institution such as this, but how far would the evidence adduced from such researches be accepted as satisfactory by the parties most interested, in many cases the consumers, when a difference of opinion existed as to the cause of any such unusual behavior of material? Naturally they would also have opinions of their own, and these would tend to lean in their own favor. Here was a tribunal where all the evidence must bear the most thorough sifting, with certainly no favor.

In microscopic examinations, particularly when conducted by manufacturers, the indications on the strength of which conclusions are based, if they are to be of much practical use, should be of such a nature as not only to be apparent and to carry conviction to men not specially trained in microscopy, but also such as can be placed permanently on record. These conditions are of course difficult to meet, particularly as with regard to the latter it is impossible to reproduce appearances by photography with anything like the clearness they are seen under the microscope. As a set-off, however, there is the advantage in comparing samples with standards of not having to trust to memory, but being able to make careful and deliberate comparisons of the two side by side.

A good deal of attention has been given to the microscopical examination of hard (tool) steel, and to medium grades, and much has already been published thereon, but so far, with the exception of Mr. Stead's able paper* dealing with rectangular brittleness, very little has been said of the great and important subject of structural or soft steel, containing from about 0.1% to 0.16% carbon, and down to the very softest, containing 0.03% carbon. Yet there is no steel more liable to mistreatment, because no steel is used for a larger variety of purposes, and put in a partially worked-up state into a greater number of hands of all degrees of experience. It is subjected to all kinds of treatment, and often successive treatments, of the precise nature of which, or the requirements expected of it when finished, very little information generally is given to the maker. Further, such treatment is not usually regulated with consideration for the material itself, but with a view to the minimum trouble and cost of product. On the whole it is wonderful how well it stands such usage, and how very few complaints are heard.

Let me remark incidentally here that there is no such thing as a "best for all purposes steel." For instance, it is impossible that a steel shall be the very best for welding, and at the same time the softest; or simultaneously for forgings and for rivets; or for electrical conductivity and for turning purposes; or for cold rolling and pickling, and also to show the greatest number of twists, with great elongation and low tensile strain. Yet it is not uncommon for such opposite requirements to be specified, or steel to be bought without any indication for the purpose for which it is intended, and expected to give the best results for all of these requirements. It would be much to the benefit of both the user and maker if the fullest particulars were always given both as to the ultimate purpose and the treatment the material would have to undergo in the intermediate processes. This is one direction in which the study of effects of different kinds of known treatment on steel should be of value, another is the detection of what treatment pieces of steel of unknown history have undergone.

A good many isolated facts bearing on the subject are already known, and some investigations have been published from time to time, but it is most important they should be collected and classified, widely discussed, and such as have been repeatedly verified fully recognized, together with the limitations of their applicability, and that such as are not correct be expunged. Again, certain modes of treatment are liable to be assumed to give the same result, and in some cases may do so, but in forming the foundations of a system, where we require absolute facts, we must not take this for granted, as, for instance, steel heated to (1) normal heat, and steel heated to (2) higher than normal heat, or to (3) normal heat for longer than normal time; provided work in such cases is continued down to a low red heat. Similarly, (1) steel of normal behavior reheated, and (2) steel of abnormal behavior reheated, and which by reheating has had its toughness and softness restored, although till this was done, whilst chemically soft and good, it was mechanically hard or brittle. It is something if we only establish that they are similar, and may be regarded as such in future, or if not, wherein the difference lies.

Having for many years taken the greatest interest in and studied closely the effects of various kinds of treatment on steel, particularly soft steel, chiefly by methods other than the microscope, and in May, 1898, brought before you some matter of this nature, as it bore somewhat on what I have now to bring before you, I trust I may remind you of some of the points previously verified. These are: (1) That good normal steel, or steel of the very purest quality, which was heated for a short time (three to five minutes) to a high temperature (near to welding but not to burning) and allowed to cool very slowly, developed large grains and became very brittle, or more properly weak or rotten, breaking generally with the first blow, with little or no deflection. The grains were generally so large that micro-photographs were unnecessary. (2) That the same steel treated in the same way throughout, except that it was chilled, showed almost the same degree of weakness, the chilling not having been able sufficiently to break up the structure to restore toughness. (3) That the same steel heated for a long time (say 3½ hrs.) at a quite normal and what is generally considered harmless reheating temperature,* and either allowed to cool slowly or chilled, showed the same properties. (4) That reheating to cherry redness (900° C. or over), whether allowed to cool slowly or chilled, restored the toughness in steel which had become brittle from any of the above causes. Special stress was laid on the reheating being rapid.† (5) That the restoration of toughness was due to the breaking up of the grain. (6) That steel of the same quality became very brittle if worked at a blue heat. (7) That reheating restored the toughness in steel rendered brittle by this means also.

I propose then, in the present paper, to show you how I have sought to systematize the microscopic study of steel and render it available for everyday use in a busy laboratory, where commercial objects must ever predominate, so that it may be carried on with the minimum demands on time, or of specially expensive appliances, or other serious cost, and shall be of such value as to really have a raison d'être; also to give you briefly the lines followed, together with some of the results of our study of soft steel up to the present time.

An endeavor has been made to take the matter up at the point at which it may be considered as purely scientific, and to lay it out on practical lines. In view of the great desire that has been felt of late years to obtain universally recognized standard methods of ordinary analysis, it would be a great advantage if, from the outset, microscopic analysis can be worked out on definite and systematic lines which have met with general approval.

It is sought to show what can and cannot be done by it, and to obtain recognition for it, and for certain definite principles of examination, and also for the fact that every piece of steel to a certain extent bears its own history recorded in it.

To any one who has not studied the subject this will perhaps seem at first well-nigh impossible, seeing that not only do no two sections on examination show exactly the same appearance, but that the very same piece of steel can show such different appearances, according to the part the section is cut from, the way it is etched and illuminated, etc., but on examining a large number of pieces of steel of a given type, it will be found that there are certain characteristics common to all, and it is these that we must first determine for that type.

Having ascertained these for a number of known or standard types, and familiarized ourselves with them, we can then begin making comparisons with other samples, the type of which we do not yet know, to see whether they have characteristics in common with any of the known types. Thus we evolve our rules for interpretation by successive comparisons, and hence it is all-important that the comparisons should be made under strictly uniform conditions. We have seen, then, that the history can only be read by comparison with other samples which have undergone definite known treatment, viz., standards. But for conclusions to be reliable, let me urge the necessity of broad bases from which to draw them. There should be plenty of standards to compare with, which have undergone each particular kind of treatment, and these should not be confined to any one make of steel. Indeed, it is questionable whether any trait should, with present experience, be accepted which is not met with in steels of all makes of that particular type, and the steels so far examined are by eight well-known makers and four processes.

Again, although of course in case of any steel behaving abnormally it is always desirable to obtain for comparison a piece of the same type of steel which has behaved normally, this in itself may not be sufficient. It is necessary, in the first place, to have ensured that all the conditions of sampling and preparation shall really be identical and not left to chance, and that there is nothing in the composition to account for the difference found. Even then, without more experience than that gained by the comparison of an occasional pair of samples now and then, it does not follow that any difference found is the cause for the different behavior. Hence the importance of a constant and systematic study along definite lines.

All this of course involves dealing with a large number of samples, hence the necessity of quick preparation of sections and photographs, so simplified that assistants can perform this as readily and accurately as an ordinary analysis. At present we have reached a stage that, from the time of receiving a sample, it can be sectioned, ground, etched, examined, photographed and a finished print produced, in cases of urgency, in about two hours, which is generally a good deal sooner than the analysis for carbon, silicon, phosphorus and manganese is performed, to say nothing of sulphur.

Method of Procedure.

Classification.—The following is the system of classification on which we are working, which, it will be seen, whilst covering the most important groups, admits of expansion to any extent, as occasion arises:

Class I.—Soft steel of normal treatment and normal composition, i. e., steel which has stood the normal processes satisfactorily and has given the normal commercial results, such as softness, toughness, soundness or other qualities. Then repeat for

Class II.—Steel of normal treatment but abnormal composition, results known. (See Table I.)

Class III.—Steel of known abnormal treatment and normal composition, results known. (a) "Soaked longer than usual at normal temperature, and treated afterwards in various ways. (b) Heated to too high temperature for short time, and no work, or work finished at too high a temperature. (c) Heated to too high temperature for short time, but worked down to normal finishing temperature—low red heat. (d) Work continued to too low a temperature (as blue-heat or cold).

Class IV.—Steel of known abnormal treatment and abnormal composition, results known.

Class V.—Steel of known abnormal results, treatment unknown. (a) "Dry" opens at ends in rolling. (b) "Red-short," ragged edges. (c) "Hard;" poor elongation, twists or bend tests, and high tensile strain. (d) Cold-short or brittle, to a moderate extent. (e) "Rotten," "breaks like pot." (f) Hollow, seamy or laminated. (g) Blistered.

Medium and hard steel can follow on exactly the same lines. A summary of the main features of each of these classes will be found farther on.

It will no doubt be obvious that, as far as possible, the sample to be examined and the standard with which it is compared should be not only of the same or similar make of steel, but of the same or similar section or sectional area; this is particularly so on account of the different size of grain in pieces of different area. In the case of examination of steel which has behaved abnormally, the standard should if possible be another piece of the same maker's steel, worked up as nearly as the user can judge under the same conditions, but which has behaved normally.

Size of Grain.—It may prove a definite rule that in normal steel, for sections of such a size that they are finished below the critical temperature* but not below low red, under similar heat conditions (i. e., finished at the same or pro rata temperature and subjected to the same cooling influences), in steel of the

*"Journal" of the Institute, 1898.

*Mr. Stead has shown that similar changes, as far as the grain is concerned, but not accompanied by as much brittleness, are produced by very long heating (say 48 hours) at a low red temperature.

†Mr. Stead has also shown that (with more or less uncertainty) breaking up of the grain and corresponding restoration of toughness is brought about by slow reheating below 900° (say about 700°, viz. reannealing).

*The temperature above which work does not reduce the size of grain, as described by Brinell.

same composition, the size of the grain is inversely proportional to the sectional area, and when it is not so this gives us an indication of the variation in the other conditions. So far, all the measurements taken closely confirm this, as shown in the accompanying diagram (Fig. 1), in the smaller sizes the influence of decreased finishing temperature being more marked. Therefore the size of grain in any piece of steel in relation to the sectional area of the piece is of very considerable importance.

It may be well to state here that by size of grain is meant the average "maximum size" of grain or the average size of grain of which a full sectional area is presented. A great many of what appear to be grains are only sections of one part or corner of the grains, and the more homogeneous and broken up the structure is the more this is so, whilst the more completely the grain has been able to form (or crystallize out) and the more regu-

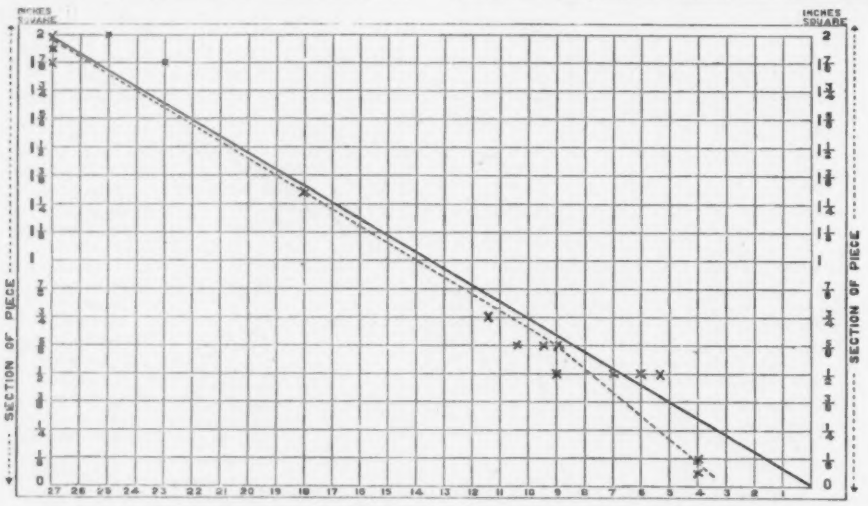


FIG. 1.—DIAGRAM SHOWING SIZE OF GRAIN IN VARIOUS SIZE SECTIONS OF NORMAL SOFT STEELS OF VARIOUS MAKES.

(Solid line shows size of grain as between extremes if assumed to vary strictly inversely as sectional area; dotted line shows actual measurement made so far of size of grain, each cross representing in many cases several separate samples.)

lar it is, the larger and better defined the sectional areas are. For a strict comparison of the size of grain, therefore, it appears to be more accurate to measure only what appear to be full-sized sectional areas. Mr. Stead suggested this mode of procedure to me some months ago, and it has been followed throughout our investigation.

System of Examination.—The following is the system of examination generally followed (1) under oblique light (Sorby's parabolic reflector); (2) vertical light (Sorby's angle 45° reflector), both for low powers only, as 20 to 50 dia.; also under vertical light (Beck's illuminator) for high powers, 100 to 1,000 diameter: Plain Polished.—Examine for pathological defects such as: Cracks round edges, spilliness and shelliness, seams, laps, etc.; red-shortness, cracks round edge or in body; blow-holes and sponginess; slaggy matter, segregations; hollowness (piping); grain, whether shown in relief. Heated till Straw Color.—In some cases shows certain of the above more plainly, or enables better photographs to be taken. Light Etching as Iodine (half saturated solution in alcohol).—All the foregoing under a different aspect; size of grain; disposition of grain and granular junctions; definition of grain. From the above are obtained the deductions immediately following: Deeper Etching, as Nitric Acid of Varying Strengths, 10% and 20%.—All the foregoing under a different aspect.

For the benefit of those who decide to prosecute this study, as it is to many new ground, to save them the labor of looking up the various works and papers on microscopy, photography, etc., and to assist them to decide on details of working, and particularly with a view to unifying the system of examination, it will perhaps be of use to give as an appendix particulars as to a number of points of practical manipulation, showing what, up to present date, we have found most feasible for everyday rapid work.

Results Obtained.

The following are some of the conclusions arrived at from the examination at low powers as 50 diameters, light etching, of a very large number of samples, and for which the evidence so far seems to be sufficient to warrant the indication given being put forward tentatively as definite tests, though it is to be hoped other workers will follow up the investigation and establish them more completely, or modify them, as may be required:

Class I. Normal Steel.—Steel in which work has been continued to below critical temperature, viz., to from good red to low red; shows what may be termed an "uninteresting" or regular structure which is almost homogeneous, the grains small and often ill-defined. The grains at the outer edge of the piece are at least as small and frequently smaller than at the center, owing to the work on the outside. This is an important feature. They continue right up to the edge. On several of the photographs a narrow strip of white, due to light reflected on the slight bevel unavoidable in rapid practice, is seen, but is not at all to be confounded with the carbonless band in Class III., a, b, c. Still less is there any danger in practical observation of misconception on this account.

Class II. Steel of Normal Treatment but Abnormal Composition: Results known.—What has already been said of Class I. applies in the main to this class also, for it should be remembered that we are not considering freaks with 1 to 4% of impurities, made simply as extremes for purposes of purely scientific interest, but ordinary commercial soft steels in which the carbon certainly will not exceed 0.20%, nor the manganese 0.60%, and which, if they contained as much as 0.10% of either silicon, sulphur or phosphorus, would be regarded as of abnormal composition. Within these limits the grain size is practically unaffected. It therefore may be safely concluded, should the grain differ much from that in normal steel, even though the composition is "abnormal" within the limits stated, that this must be attributed to other causes, such as the treatment whilst working, and not to the slightly increased impurities..

Class III., a, b, c.—Steel that has been heated too long or to too high temperature, or finished too hot, but without burning, shows, according to the extent and manner in which this has been done, either an outer "carbonless" ring, or a ring of large grains, the grains being larger at the outside than further in, which is the reverse of what is found in normal steel, and is a sure sign of the above treatment. This carbonless ring is often, with light etching, plainer to the eye than by the aid of the microscope. Sometimes, generally with deeper etching, it appears to the eye as a dark band. At the edge sometimes the grains are quite separated, the junctions being wide open. Then it is approaching to "burnt" steel.

Class III., d.—Steel on which work has been continued to too low a temperature; (a) To blue heat, or through blue to straw; (b) Steel worked cold:

(a) Steel worked at or through blue heat.—In order properly to understand what to look for, let us consider what takes place when steel is worked at various temperatures. If worked only above critical temperatures, which for soft steel is from good yellow to white or welding heat, and allowed to (1) cool slowly, the size of grain is affected very little or not at all by the work, and when cold a section shows no flow-lines or signs of deformation, though if of small enough mass to be able to be

(2) Chilled sufficiently rapidly, such signs may be seen. For instance, a cross, in a small bar forged to low yellow heat and then suddenly chilled. In the first case, slow cooling from a high temperature allowed grains to arrange themselves and flow-lines to dissipate. The material being quite plastic at the temperature at which worked, the grains could move freely, hence their contact is good and the junctions sound; but if chilled before they have rearranged themselves, signs of the flow are left.

If worked to below the critical (viz., to a normal) temperature, say good red to low red, the grain becomes smaller, and well interlocked or homogeneous, and when cold flow-lines are more or less distinct, according to the temperature, mass, and rate of cooling. In this case, too, the material being plastic at the temperature at which worked, the grain contact is good and their junctions sound. If worked through or to blue heat, or subjected to shocks at this temperature, the effect tends in the same direction, but meets with a new limitation. The material at this temperature appears to be in its condition of minimum plasticity. If the blow or work is too light to distort the piece, it simply sets up a state of strain at the surface, which penetrates more or less deeply, according to the force exerted.

Provided there is no actual distortion, however near the force has come to producing it, there can be no evidence visible through the microscope. The same will be true provided the distortion is not sufficient to yield flow-lines which can be distinctly recognized, although there may be a considerable state of internal strain or predisposition to rupture. When the force is more powerful, notable distortion takes place, and its evidences, which take many varied forms, are clearly revealed by the microscope.

According to the nature of the work, whether light and rapid, as in hand-hammering, heavier and less rapid, as in steam-hammering (the work in these cases being shock), or whether strong and steadily applied, as in rolling, and according also to the mass of the piece subjected to it, so the visible effects vary, both in character and in the extent to which they penetrate the mass or are confined to the surface.

We have so far noticed the following indications, either or all of which may be present, and which are best seen by vertical illumination: (1) Breaking up of the grain at the surface, penetrating more or less deeply. (2) Loosening of the grain or opening of the granular junctions, and frequently actual rupture. (3) Flow-lines in various directions from the part where the force was applied, marking the direction in which the material has slipped, and indicating lines of weakness, the portions which have slipped being also in a strained or disturbed condition, these flow-lines culminating in (4) Cracks of all degrees.

Apart from the local indications 1 and 2, there is no special size of grain associated with steel which has had work at a blue heat, this being determined, as usual, by the mass of the piece and its previous history. If the grain has been large before, it is still large except at the parts where work has broken it up, if it has taken effect in this way. This is the case if a piece of steel has been heated to above critical temperature, say to good yellow heat, and allowed to cool slowly without work on it till below red heat, and explains the increased brittleness found under these conditions and described by the author, p. 225, in the paper on "Brittleness in Soft Steel," read before this Institute, May, 1898, the reason being, of course, that the grains, and hence the continuous junctions, are larger.

The flow-lines in square bars are frequently at an angle of 30° to 45° to the surface, and in such cases often take the form of a more or less regular and complete cross, which may have straight or curved arms—apparently the harder the material at the time of forging, the straighter the arms of the crosses, whilst if softer they are more curved, also those in hand-hammered bars being less regular, and those in steam-hammered bars more regular, being generally more marked in proportion to the degree to which brittleness has been developed. In other shaped pieces the flow-lines are not so distinct or regular. The flow-lines, though sometimes visible before etching, are brought up much more clearly by it. They are frequently visible to the naked eye as dark markings on the surface. They are no doubt apparent on account of the different orientation of the crystals in the portions which have slipped, as compared with that of the adjoining portions. If by chance the orientation were the same in the adjoining portions, the flow-lines would be no longer apparent, which may perhaps account for the imperfection of parts of the crosses in certain cases.

Anton R. von Dormus* mentions some crosses visible to the naked eye in forged bars of hard (chisel) steel. He attributes the different appearance in that case to a difference between the carbon of the inner and outer portions, and reference is only made to them as bearing on the direction of flow in forged bars. Flow-lines, whether in the form of a cross or otherwise, are not in themselves a distinctive indication of work at a blue heat.

To sum up the causes of "blue-heat brittleness," there is no evidence so far of it being due to symmetrical arrangement of the crystals, or, indeed, to any particular structure per se, but to strains, and more or less complete rupture of a number of individual granular junctions or cleavages, developing sometimes into continuous cracks, all being due to distortion produced by work when the material is in its least plastic condition, i. e., at that particular temperature when, owing to its hard or brittle state, work is able to produce these effects.

Indeed, microscopic examination and other evidence brings out clearly the vital fact that while it is at a blue heat, steel is in a condition of peculiar receptivity or sensitiveness to retain in permanent form (strains, cracks, etc.) the effects of shock or work. No doubt this retention of the effects (besides actual cracks formed at the time, which no subsequent treatment could remove) is largely due to there not being sufficient heat for the parts which are merely strained to readjust themselves whilst cooling, as is the case when work is finished at a red heat, and still more so when finished at a yellow heat. There can be no question as to the brittleness being per-

*Weitere Studien uber Schienenstahl. Anton R. von Dormus, Ingenieur der Kaiser-Ferdinand-Nordbahn. Oesterr. Ingenieur und Architekten-Vereins. Wien, March 26, 1898.

Section.	No Further Treatment.	Further Treatment.				
	Just as left after hot work finished.	Pickled.	Cold Worked, Rolled, Drawn, Stamped, &c. (generally pickled first).	Reheated after no Previous Treatment.	Reheated after Pickling or Cold Work.	Coated with Zinc, Tin, or Lead.
	Average "maximum" grains, approximate mean diameter.					
Billets, 1½ in. to 4 in.	2 in. ·0027 to ·0030	Grain size not altered.	Grain broken up small on surface extending inward to varying extent according to amount and nature of work	If heated to cherry redness for a short time practically no change in size, except any odd large grains broken up smaller and homogeneity thus increased. If at higher temperature, for a long time grain grows larger according to length of time, and very rapidly for high temperatures, as welding. By excessive treatment in either respect they may grow to enormous size.	If to good cherry redness grains restored gradually to normal size.	No particular effect observed so far on size of grain.
Slabs, bars, and other large sections	Grain follows most nearly in size the least dimension, though if mass retains heat, is somewhat greater than a square bar of size of least dimension					
Bars, forged, &c., 2 in. to 1 in. sq.	½ in. round ·0005 to ·0008 ½ in. square ·0007 to ·0010 ½ in. round ·0008 to ·00125 (In rounds slightly smaller than in squares because less mass)					
Thick plate, ½ in. to 1 in.	½ in. ·0007 to ·0012 ½ in. ·0008 to ·0013 (same applies largely as stated for slabs)					
Thin plate, ⅛ in. to ½ in. Sheet and hoop up to ⅛ in. thick	⅛ in. ·0003, ·0005 ⅛ in. ·0003, ·0005 (pretty much as sheet)					
Rod and thick wire, up to ½ in. and ⅛ in.	½ in. ·0003, ·0005 ½ in. ·0005, ·0008 ½ in. (see above)					
Thin wire, up to ⅛ in.	Controlled by area and mass					
Other sections						

TABLE I.—ILLUSTRATING STANDARD MICROSCOPIC ANALYSES OF STEELS BELONGING TO CLASSES I. AND II.

manent. Samples prepared eleven years ago, viz., in 1888, were recently broken, and were still as brittle as ever.

As further showing that the brittleness is not necessarily due merely to surface distortion or to cracks actually developed, but also to state of strain and hard condition which has equally been retained, a sample from which the outer 1/16-in. was filed (thus removing any surface cracks), though it did not break without deflection as before, broke on bending through 40°, and was therefore not tough. The crosses going right through the pieces also show that the effects are more than superficial, whilst the cutting, filing, grinding and polishing give abundant proof of the greater hardness right through.

The practical question as to what amount of shock or work at blue heat is necessary to cause brittleness is one which cannot be answered exactly, but there have been plenty of instances where in the case of plates the work and conditions they have gone through, together with subsequent vibration or shock, have been sufficient to cause fracture.

The question why steel is peculiarly sensitive at these temperatures still remains unanswered. But, however interesting it might be to pursue the inquiry, it is not of practical importance, it has not incidentally been revealed by the microscopic examination, and it is outside the scope of this paper.

(b) Steel Worked Cold.—The same general features are presented as in steel worked at blue heat, but for the same amount of work the effects of distortion are not apparent to so great an extent owing to the greater plasticity of the material at that temperature. Provided the work is sufficiently severe, almost identical effect may be produced though there is not so much of the appearance of "loosening" of the individual grains. The blue-heat worked bars were not perceptibly reduced in size, and the hammering was relatively light; even when steam-hammered, the blows were as light as possible. The flow in a cold-sheared plate is also clearly visible, and shows the pull particularly at the last part of the cut.

Attention may here be drawn to a point of considerable practical importance which is by no means as widely recognized as it should be, viz., the undoubted fact that both surface cracks and hollowness in the mass can be developed in material at points where it was before perfectly sound, by work at too low a temperature. This seems to be particularly the case with forging, where the work is applied in a succession of local shocks repeated at certain points, thus producing an accentuated flow or creep along corresponding lines, and a more or less symmetrical disposition of material. Indeed the Mannesmann Tube Process depends entirely for its success on the readiness with which, under certain conditions, even in hot material unsoundness can be produced in the center of sound steel. Note also the increased tendency to lamination in plates and sheets, and to blistering in tinplates and cold rolled bright strips, even the "hot" work on which is often very near blue heat, and which also often undergo further cold rolling. There can be no doubt that the surface and interior do not spread equally, the difference at times being so great as to cause rupture along the lines of flow, which is frequently revealed on pickling.

The author is quite aware that it is usual to attribute this wholly to blow-holes, but it does not follow that because certain sheets are sound, the steel from which they were made had no blow-holes. Blow-holes exist to a greater or less extent in all steel of every make, but the work the material undergoes closes them up, and it depends very largely on the condition of further working whether or not they are reopened and manifested. What it is here sought to point out is that in a great number of instances where blisters appear these are due to variations from the normal conditions, in the temperature of working up, in pickling, etc., and it is these which have brought about an actual separation of the fiber which would not otherwise have occurred. The fact remains that the same steel, which in tinplates, etc., would give blisters, in sections of greater mass (work on which is consequently finished at a higher temperature) does not yield blisters when pickled. Either a billet, or for that matter a blistered wire rod, would be a curiosity worthy of sending to the British Museum. The fact is, distortion strains exist in all worked material at the time of working (though of course they are less the softer the material at the time of working), but when worked hot they are dissipated by slow cooling, and in most cases more or less fixed by chilling. They are also dissipated by reheating.

The same general characteristics as have been described for cold-worked soft steel, viz., the flow following the lines of force, have already been shown for hard steel by Mr. Stead* in his now well-known photographs of the effect of wear on a rail, tire, and chisel steel. The causes are the same as in cold and blue-heat worked soft steel; work causing compression of the surface, hence flow, hence weakened cohesion of the mass affected.

Although there is perhaps, in the absence of knowledge as to the amount of work which a sample has undergone, no very distinct indication as to whether brittleness has been produced by work at blue heat or work whilst cold, in practice this is hardly likely to prove a difficulty, as the conditions of manufacture will generally be sufficiently well known, or even apparent from the piece itself. Indeed, in seeking for the cause of brittleness in any particular instance, the evidence which the microscope affords as to blue or cold working may be rather of a negative character, viz., the absence of evidence of excessive or prolonged heating. If the sample is thin and the brittleness is not due to composition, weld-heating, soaking or excessive oxidation, then it is necessarily due to blue or cold working, and which of these, as already stated, can generally be distinguished.

Class IV. Steel of known Abnormal Treatment, and Abnormal Composition, results known.—Just as Class II. in the main closely resembles Class I., so Class IV., broadly speaking, resembles Class III., only as fresh factors are introduced the results obtained are correspondingly varied.

Class V. Steel of known Abnormal Results, treatment unknown.—Steel of this class should always be analyzed, and its composition borne in mind when examining it microscopically, and special endeavor should be made to procure suitable standards, as referred to already. The different features of one or other of the previous classes will no doubt be met with and readily identified.

Conditions (a) and (b).—If the steel on analysis proves to have been of suitable composition for the purpose for which it has been used, faults of this class generally prove to be varieties of burning, but it would take too long to deal with this here, and as a good deal has already been published on the subject, and a number of examples shown by other writers, it is not proposed here to go into it to any length. The ordinary indications are frequently sufficiently unmistakable without the aid of a microscope, and it is generally only needed to determine whether, in the cases of certain sections, tears and cracks are due to pull of the rolls through improper drafting or feeding, or to red-shortness. The characteristics are those of Class III. (a), (b), (c), but intensified, according to the extent burnt. There is the carbonless ring or band along the edge penetrating more or less deeply, accompanied by oxide cracks and fissures between the grains, these latter generally being quite plain when the section is examined in the polished state before etching. Conditions (c), (d) and (e) generally prove to be due to the same causes as in Class III., (a), (b), (c) or (d), if steel has been of suitable composition for the purpose used. Conditions (f) and (g) are mechanical defects which may easily be recognized, and the accompanying structure generally shows quite clearly whether these have been initial defects present in the steel when supplied, or whether there has been anything in the subsequent treatment of the steel to account for them.

In conclusion, the whole object of the investigation described in the present paper has been to obtain information, deductions from which shall be of practical use, such as data (a) To confirm definitely what are generally accepted as correct conclusions, but for which such definite data were not published; (b) To show how certain behavior under mechanical or physical treatment is brought about, and hence, by inference, how to avoid such behavior if objectionable; (c) As to the indications that steel is likely to show certain behavior, beyond what can be judged by composition.

The time has now arrived when it should be well recognized that composition only indicates such well-defined effects as are generally understood without certain narrow limits of treatment, which are termed "normal." The moment we get outside these limits, the effect of the treatment far outweighs that of the composition. Often so-called "normal" treatment in manufacturing processes is really abnormal, i. e., the effect of the treatment has outweighed that of the composition. Makers of steel can only control the composition, which is often the least powerful factor, so it is most important that, since competition frequently leads users to more or less abnormal or unsuitable treatment, they should understand what it does. While it is objectionable to dogmatize—and in advancing any views at all there is always a risk of being afterwards proved to have drawn wrong conclusions, especially if a subject be looked at too narrowly, as exceptions can always be found—still, if progress is to be made, definite statements must be formulated as starting-points.

Practical Manipulation Details.

Sampling.—It is not practicable to section the whole area of large pieces, say over ⅝-in. square, and in most cases a total area of ¼-in. to ⅜-in. square is preferable. It is therefore important to follow a fixed rule, and always cut the section from one definite position, so as to be of value for comparison. This is more obvious as the grain may vary a good deal from the center to the outside in sections of large area.* The section cut can of course be a cross section, or one parallel with the direction of rolling, or a section of the outside surface. For many purposes, including grain measurement, we prefer the cross section, and this may be sufficient, though in some cases the other sections are desirable.

The sketches Fig. 2 will illustrate the general principle. In billets half the section, 3/16-in. thick, is sliced off. Then the strip AB is cut, forming a section from opposite

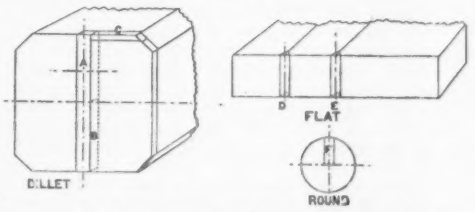


Fig. 2.—Sketches Showing Method of Selecting Sections for Microscopic Analyses.

sides right across the center; this is again cut in half, each half showing all the variations from center to outside, and the center of each half, i. e., the part midway between the center and outside of the billet, is perhaps most truly representative of the whole. Strip A is polished on the face shown, thus being a cross section. Strip B is polished so as to give a section in the direction of rolling or side elevation of the section, and if desired C can be cut and polished to show a plan of the surface.

For flats the position most truly representative of the mass is along the line midway between the center and outside as D, but whether the cross section be taken at this point or along the center line as E, a V-shaped cut, having a face 3/16-in. broad, will in most cases be sufficient, and less trouble than cutting off a full slice. The

*West of Scotland Institute, No. I., Vol. IV., November, 1896, "Micro-Mechanical Examination of Old Steel Rails and Tires."

*Mr. Albert Sauveur drew attention to this in the case of rails in his paper on the "Microstructure of Steel," before the American Institute of Mining Engineers, August, 1898.

two ends of the section so cut will represent two outer sides. From rounds, if only about ⅝-in. diameter, a full slice is cut, but if larger than this, a half section is cut and then the piece marked F cut out of it. For very small sections, as wire, thin sheets, etc., it is convenient to fix a number together by forcing them tightly into a piece of bicycle or other steel tube, or binding with tin sheet, and filling up the interstices with fusible metal such as melts at below the boiling point of water—which low heat insures that there shall be no interference with the structure. A section is then sawn off the whole. Sections are never cut too near to any distorted part, such as a sheared edge or fracture, since the grain arrangement is not normal in such a case.

Grinding.—This is done substantially as already described by Mr. Stead and others. For most purposes we give the following treatment: Rough filing; fine filing; rough commercial emery cloth stretched on a board; fine emery cloth stretched on a board; finer specially prepared emery paper on disc in Mr. Stead's polishing machine; diamantine on cloth on disc in Mr. Stead's polishing machine; rouge on wash-leather on disc in Mr. Stead's polishing machine; rouge on wetted parchment stretched on glass for very fine work. For most purposes exceedingly fine polish free from all scratches is not necessary.

Mounting.—The sections are mounted by means of a microtome, with a very little ordinary modelling material (a sort of grease and clay mixture which always remains plastic).*

Protecting.—If now or at any later stage the surface requires protection from corrosion, a drop of solution of resin in benzol is put on it. This, when required, can be at once removed by benzol and a clean, soft rag.* Definition of grains, especially by oblique illumination, is often lost on removal of this, but it is the best method we know of so far. In spite of this, if samples are kept in a place that is at all damp, streaks of rust work under it.

Etching.—For determination of size and definition of the grain, a solution of iodine in alcohol is generally most suitable, and the operation can be conducted under the microscope, and being watched whilst in progress, can be judged to a nicety. Usually one to two minutes is sufficient. The section is then washed with a few drops of methylated spirit, and generally rubbed with the finger to avoid spurious markings, then pure alcohol, and dried by rapid motion or heat; and generally it is rubbed with wash-leather. When finished it is so light that usually it can hardly be seen with the naked eye. Etching with acid, on account of the bubbles and acid spray and vapors given off, is far more likely to injure the reflector, so this is not generally done under the microscope. Sections are then washed with water, lime water, water again, methylated spirit, and pure alcohol. Care must in all cases be taken that the etching fluid evenly and simultaneously covers the whole area of the section, otherwise various markings and other differences may result, which will give rise to misleading conclusions, especially as the relative rate of attack is sometimes of considerable significance.

Illumination.—For moderate powers, such as can be obtained from a 1-in. objective, oblique illumination with Sorby's parabolic reflector, gives a more general and detailed, or what may be termed "prospective" view, and in most cases is useful for grain measurements, showing the grain outlines sufficiently clearly. Sorby's 45° reflector gives a "plan" or view of the grain outlines, illumination being vertical, and in some cases is preferable. For instance, flow lines which are scarcely noticeable under oblique illumination may be easily apparent with this. In both the above cases it is better to have previously removed the glass disc of the Beck's illuminator, if this is also fitted on the microscope. Beck's illuminator is chiefly useful for higher powers, as ¼-in. and ⅛-in. objectives—for which it is indispensable—with 1-in. objectives, and a low-power eyepiece, as No. 1 or 2; this latter form of illuminator does not give a full field. It gives vertical illumination. An incandescent gaslight, with a reflector behind and condensers in front, will be found a most satisfactory source of light.

Examination.—Just as care is taken that the section cut shall represent as nearly as possible the whole of the piece from which it is cut, so equal care should be exercised not only that the whole section cut should be examined, but that the part of it selected for the photograph should be strictly representative of it. It is important to keep this ever before one's mind, and not to be tempted into keeping as a record a part which is not strictly representative, simply because it is curious or interesting. It is always well to make notes at the time of examination, as even the best photographs cannot show up the various characteristics as plainly as they appear to the eye. Though it is useful for comparative results as far as possible always to keep a record at one fixed magnification (say, for instance, 50 diameters), it is better, in addition to this, to examine it at two or three different powers, say at least with different eyepieces and frequently different objectives. An examination of the image on a clear-glass focussing screen with an eyepiece will, however, give a still greater magnification.

Photographing.—Focussing is by no means always easy, owing to the great dispersion of light in higher powers. For locating the extent of the field, so as to find the position of any part of it such as the edge of the piece, on an exact position on the plate; also, for giving a correct idea as to how the photograph will appear, a finely ground glass disc is very useful. With low powers, say up to 50 diameters, focussing can be clearly and sharply done on it. To ensure very sharp focussing, a clear-glass screen and examination with a low-power eyepiece is preferable. Indeed, for very high powers this is practically indispensable. We generally examine with both, especially since the latter, as already mentioned, gives a very good idea of the appearance under increased magnification. The clear-glass is not indispensable, and has the disadvantage of being easily dulled by the breath, but it is more exact than merely holding the eyepiece in the right position.

We prefer, for comparative work, to always have the focussing screen at a fixed distance from the eyepiece, viz., 9 ins. This saves complication, especially in grain measurements.

For cheapness and handiness, we use ¼ plates of a moderately rapid make. From 35 to 110 diameters, an exposure of 5 to 12 minutes with oblique light, and 4 to 9 minutes with the 45° reflector, is usually sufficient; whilst for 300 diameters, 35 minutes with vertical light. Higher powers pro rata. If prints are wanted very quickly, immediately the negative is rinsed it can be steeped in methylated spirit, and dried within two to five minutes. After taking the prints required, the usual washing can be done before storage. In printing it has been considered best to be independent of daylight, and use bromide paper, a slow type giving density, being preferred. Enamelled paper gives better detail than matt surface. The exposure varies from two to five seconds at 2 ft. from an incandescent gaslight, but for weak or dense negatives can be humored to a large extent. With care, it is almost impossible to have a failure. The print should be washed for at least one hour, though in urgent cases, where durability is of secondary consideration, less will suffice, and in this case, too, it can (like the negatives) be dried with the use of spirit.

Mounting.—"Slip-in" mounts and books will be found most convenient. The following table shows the average time, in urgent cases, of making a complete micro-photograph:

	Mins.
Sawing off section according to size of piece from which cut	1 to 5
Grinding and polishing	15 to 30
Polish examination	2 to 3
Etching and washing	3 to 5
Examination and photographing	7 to 10
Developing, fixing, rinsing and drying negative	15 to 15
Printing	2 to 2
Developing, fixing and rinsing print	15 to 20
Washing and drying in spirit	60 to 60
Total	120 to 150
	2 to 2½ hrs.

Grain Measurement and Comparison.—For practical purposes, the exact measurement of the outline of all the grains with a planimeter, as described by Mr. Sauveur,* is too tedious. The best general idea of the relative structure of the standard and the piece being examined is obtained by comparing the photographs of each on exactly the same scale. This is why uniform treatment of standards and samples at all points throughout has been advocated strongly, and if they are selected to correspond with each other within reasonable limits, the range of effects produced by uniform treatment is not too great for reliance to be placed on the results of comparison. For record it is desirable, as nearly as may be, to give a numerical value to the grain size, and this can be judged very readily and with a fair degree of accuracy by mounting the grains with scales drawn with Indian ink on clear glass, the surface of which has been prepared with retouching medium. Micrometer scales are first photographed at the same magnification as the samples, the clear-glass scales being prepared from these.

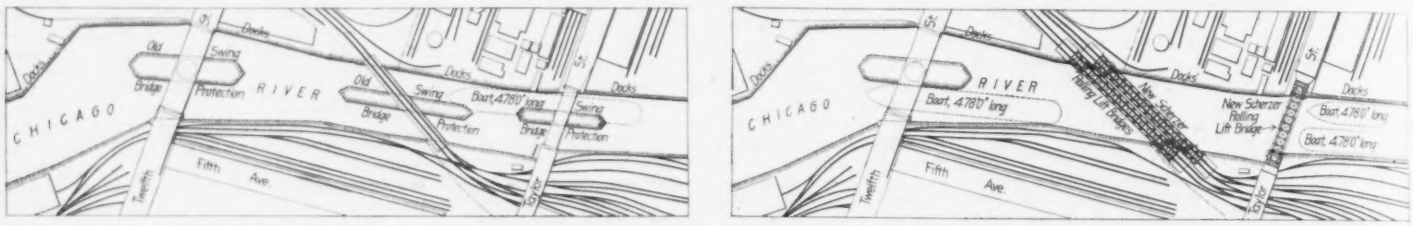
Summing up and Recording Results, etc.—This should be carefully done as the examination proceeds, and will be found of great assistance in reproducing any given effect at a future time with precision, say, for instance, a duplicate print. The records generally made, besides general remarks as to the appearance, opinion as to what the sample indicates, and anything else of note, are as follows: Number; etching medium; etching time; objective; eye-piece; magnification; illumination used; part of section photographed (whether outside or center, etc.); exposure; print exposure.

*Method suggested to us by Mr. Stead. See also his two papers, "Journal of the Iron and Steel Institute," 1894, No. I., "Methods of Preparing Polished Surfaces on Iron and Steel for Micro-Examination;" 1897, No. I., "Micro-Accessories for Metallographers."

*Transactions of the American Institute of Mining Engineers, Vol. XXII., "The Microstructure of Steel,"

BASCULE BRIDGES FOR THE CHICAGO RIVER.

There are now three Scherzer bascule bridges across the Chicago River, one being a four-track railway bridge, while the others are highway bridges. Two other bridges of this type are now to be erected, to replace old swing bridges whose center piers are to be removed in order to give the river the necessary capacity of flow required for the Chicago Drainage Canal. These two bridges will be close together. One will be at Taylor St. and the other (a little further south) will be for the Chicago Terminal Transfer Ry., forming the approach to the Grand Central terminal station. The accompanying cut shows two plans of the location, one in its present situation, and the other the river, as it will be when the center piers and draw-rests are removed. It was at first proposed to construct a by-pass, as is being done between Adams St. and Van Buren St. (Eng. News, Feb. 16, 1899), but at this place the Chief Engineer of the Drainage Board, Mr. Isham Randolph, estimated that the increased waterway would be obtained by the erection of bascule bridges at a cost of $95,000 less than the cost for a by-pass. The bridges will give a clear channel of 120 ft. between the guard piles, measured at right angles, and the river will have the required capacity of 300,000 cu. ft. per minute. The Twelfth St. swing bridge, just below, gives the necessary capacity, but is an obstruction to navigation, and will eventually have to be changed. This, however, will have to be done by the city, while the other two bridges are being built under the direction of the Drainage Board, in connection with the work on the Drainage Canal.



MAP OF THE CHICAGO RIVER, NEAR TAYLOR ST., SHOWING PRESENT OBSTRUCTION BY CENTER-PIER DRAW SPANS, AND LOCATION OF SCHERZER ROLLING LIFT BRIDGES TO REPLACE THEM.

The Taylor St. highway bridge will have a span of 148 ft. 7 ins. c. to c. of bearings, and crosses the river on a skew of 74° 10'. It is a deck bridge, and is designed in accordance with Cooper's specifications. The bridge resembles an arch, but is designed as a cantilever, the live load stresses being carried to the rear of the supporting piers by means of anchorages. It will be operated by electricity, but though provision is made for an operator on each side of the river, the machinery and electrical equipment will be so arranged that both leaves may be operated from one side. The bridge will be counterbalanced so as to be in equilibrium when opened at an angle of about 40°. This will facilitate the opening and closing, and

will also prevent any possibility of the bridge falling to the closed position through any accident to the machinery. The trusses will be 20 ft. 4 ins. apart, c. to c. The roadway will be 20 ft. wide, with a double track for street cars, and on each side there will be a sidewalk 5 ft. wide in the clear, outside of trusses. The level of the roadway will be about 30 ft. above the water line.

The bridge for the Chicago Terminal Transfer Ry., Fig. 3, will be a double-track through bridge, and will eventually be duplicated, being then operated as a single four-track bridge. It is designed as a cantilever structure, with through trusses, and will cross the river on a skew of 36° 30'. This necessitates a span of 275 ft. between end bearings in order to give the required clear channel of 120 ft. The design is based on Cooper's specifications, the loading being 10,000 lbs. per lin. ft. of bridge, with a concentrated load of 50,000 lbs. at any part of each track. The bridge will be balanced and operated in the same way as the Taylor St. bridge.

The substructures of both bridges will be of concrete masonry, faced with Bedford stone, and having foundations of piles driven to the rock. The bridges are of the Scherzer type, designed by the Scherzer Rolling Lift Bridge Co., 1612 Monadnock Block, Chicago, Ill. This company also furnish the detail plans and will supervise the erection. The contract for the substructure and superstructure of the railway bridge has been awarded to the Pennsylvania Steel Co., of Steelton, Pa.; that for the highway bridge has been awarded to the Chicago Bridge & Iron Co., of Chicago, Ill.

THE CONVENTION HALL AT KANSAS CITY, MISSOURI.

(With two-page plate.)

In most large cities private enterprise has provided buildings of great size for the special purpose of accommodating exhibitions, conventions, and public gatherings. In 1898 an exceptionally large building of this character was erected at Kansas City, Mo., and is known as the Convention Hall. In plan it is about 314 × 198¼ ft., and it has seating capacity for about 25,000 people. The building is owned by the Kansas City Convention Hall Building Co., and its cost was about $150,000. With the decorations, lighting, etc., all complete, it represents a total investment of about $240,000.

As to the great capacity of the building, it may be interesting to note that the architect states that during a convention of children's societies there were over 35,000 persons present, 30,000 of whom were children. Seats were provided for 25,400 persons.

The Convention Hall is a brick and stone structure, with a sheathed tar and gravel roof, supported by steel trusses. On the east, or rear side, the trusses rest upon brick piers carried up with the exterior walls, but upon the west, or street side, they rest upon steel columns, 18 ft. high, the architectural treatment not allowing the piers to be carried up to the level of the truss seats. These columns consist of two Z-bars ⅝ × 10 × 10 ins., set 5 ft. 4 ins. apart, c. to c., and braced together so as to form a bent. The bents supporting each pair of trusses are braced together longitudinally, and all the bents are, of course, securely anchored to the brick piers. The roller expansion bearings of the trusses rest upon these columns, and are secured against uplifting. The fixed end bearings rest upon the brick piers in the rear, and are anchored by four 1¼-in. round bolts, 12 ft. 6½ ins. long. On the rear side also, the brick wall is carried up to support the ends of the gallery beams and roof garden beams, but on the front these beams are supported by light steel columns seated on the end pins of the trusses.

As the site of the building is filled ground, the foundations for the masonry piers supporting the trusses were carried down to bed rock at a depth of from 15 to 38 ft. The piers are 7½ × 9 ft., of Louisville cement concrete.

In designing, the live load was taken at 150 lbs. per sq. ft. of floor, as required by the building law of Kansas City, and this load was considered as (1) covering the floors of galleries and roof gardens both sides of building, and (2) on but one side at a time. The specification for wind load was severe, 50 lbs. per sq. ft. both upon the outside, and from inside to outside. The snow load was taken as one-third of the dead load. The following combinations of loading were decided upon in determining the maximum stress:

(1) Dead and full live load of galleries and roof gardens, and wind at 45 miles per hour.

(2) Dead snow and gallery live load, but no load on garden, and wind at 10 lbs. pressure, or 45 miles per hour.

(3) Dead load and 50 lbs. wind pressure and inside gallery load only.

(4) Dead load and full gallery and roof garden live load one side only, and wind at 45 miles per hour.

The principal features of structural interest are in the roof trusses, which have a span of 187 ft. 4 ins., c. to c. of end pins. They support the main roof, roof garden and galleries, the lower galleries being suspended from the trusses. The lower chord of the truss is curved for æsthetic reasons, having a rise of 9 ft., the depth of truss at center being 32 ft. 6 ins., c. to c., of chords. There are ten of these trusses, set 23 ft. 6½ ins. apart, c. to c., and connected up in pairs by lateral bracing. The general arrangement is shown in Fig. 1, which is a diagram plan of the building. Nine of the trusses are identical, but the tenth is shorter, spanning the narrower end of the building. This figure also shows the top lateral bracing between the pairs of trusses.

Fig. 2 shows the construction of one of these trusses, and the connections between each pair of trusses. On the right-hand side of this cut are shown inclined beams for the galleries, but this arrangement was afterwards changed, the galleries being made horizontal so as to render the floor space available for exhibition purposes. Temporary elevated seats will be erected when the building is to be used for a convention hall. This change in design is shown on the left-hand side. The gallery beams are 18-in. I-beams. They are anchored to the wall or the steel columns, and supported by two suspension rods 1⅜ ins. square, at the first panel point, and two 1⅛-in. rods at the second panel point. The two levels of the galleries are connected at intervals by inclined planes, or gangways. Fig. 2 also shows at the left the steel posts which support the roof garden beams.

Fig. 3 shows the construction and anchorage of the 18-ft. steel columns, which, as already described, support the trusses at the front of the building.

The two views, Figs. 4 and 5, show the method of erection and the appearance of the completed roof framing. For erection purposes, a temporary traveling falsework was erected, having a gin pole at each side. In Fig. 4 will be noted one of the horizontal roof garden beams, passing through the end post of the truss and supported by the steel post or column, which is seated on the end pin of the truss. Below the truss may be seen the steel column which supports it, and which is being enclosed in the masonry of a pilaster. Fig. 5 shows the arrangement at the opposite side of the building, the beams and trusses being here supported by the brick wall and piers. Fig. 5 also shows the suspended gallery beams, and gives a good idea of the great area of the building.

Fig. 6 shows the arrangement of members of the truss at the panel points, and also the cross-sections of the trusses. Fig. 7 gives the details of section (E — G) of the top chord. This chord is of box section, about 20 × 16 ins. It has 16-in. side plates and a 20-in. top cover plate, with four flange angles. The lower flange angles are connected by lacing bars and batten plates.

The web members are composed mainly of two channels, or four angles, the latter forming an I-beam section with the connecting batten plates, as shown in Fig. 8. The center verticals, however, consist each of two eyebars, ⅞ × 6 ins. The diagonal members of the truss are each composed of two channels, with lacing bars or batten plates according to position, as indicated in Fig. 2. The details of diagonal (C — d) are shown in Fig. 9. Between alternate pairs of trusses there is a latticed portal bracing at panel points (B — B), and at most of the other panel points there is vertical diagonal bracing of ⅞-in. square rods. At (C — c), however, knee braces are used between the posts and top strut, as sway rods are not permissible. The top lateral bracing is shown in Fig. 1, the top struts being built of three angles laced, and rods ranging from ⅞-in. square at the center to 1⅛-in. square at the end panels. There are also horizontal struts for bottom lateral bracing at panel points (c) and (g).

The short truss is similar to the others, except that at the east end (right-hand) it ends at post (C — c), Fig. 2. This end panel is 12 ft. 6 ins. in length, instead of 16 ft., making the span of this truss 154 ft. 2 ins.

All the material in the trusses, with the exception of the rivets, is of open-hearth medium steel. Machined surfaces were painted with white-lead and tallow at the shops. All surfaces inaccessible after riveting were given two coats of iron ore, linseed oil paint, while surfaces that would be inaccessible after erection were given one coat of the same paint. All other surfaces were given one coat of pure boiled linseed oil, and one coat of paint was given to the work after erection.

All roof timbers and joists are bolted down, the building being designed to resist a wind pressure of 50 lbs. both from without and from the inside, as already noted. The wooden purlins are bolted to angle brackets which were bolted to the top chords of the trusses before erection. The rafters are 3 × 12 ins., with planking 2 × 4 ins., laid diagonally, and covered with roof boarding laid diagonally in the opposite direction. The main floor joists are 6 × 16 ins.

The heating and ventilation are effected by fans, and the heating has been found to be satisfactory in very cold weather. The building is also said to be thoroughly well lighted, a large portion of the gable ends being filled in with glass, while window space is provided in the walls. The acoustic properties are also reported as excellent.

The architect of the building was Mr. Frederick E. Hill, of Kansas City, who was assisted in the steel construction and in the preparation of the drawings by Mr. E. T. Morrison and Mr. B. F. Whitney, Jr., respectively. Mr. A. B. Abercrombie also assisted in the preparation of estimates, and superintended the work on the foundations. The late Mr. Robert Gilliham, M. Am. Soc. C. E., and Mr. Ira G. Hedrick, Assoc. M. Am. Soc. C. E., acted as consulting engineers for the owners in regard to the structural steel work.

The contract for the greater part of the steel work, which was the most important feature of the building, was awarded to the Gillette-Herzog Mfg. Co., of Minneapolis, Minn., on its own designs. We are indebted to Mr. F. J. Llewellyn, M. Am. Soc. C. E., Chief Engineer, and Mr. C. A. P. Turner, Assistant Engineer of the company, for blue prints, photographs and information respecting the work. As an instance of the short time which the designing engineer for a contracting firm is frequently allowed for the preparation of plans and estimates, it is of interest to note that the engineering department of the company had but two days within which to prepare the design and estimate upon which the contract was taken. In spite of this, however, the shipped weight was within about 2% of the estimated weight.

The following is a list of some of the important contracts:

Gillette-Herzog Mfg. Co., structural steel work	$30,418
G. K. Musselman, foundation and first story walls	22,625
James Cotter, heating and ventilating	9,000
Jacob Welch, brick masonry	7,923
Phoenix Cut Stone Co., cut stone work	2,826
Cotter, McDonnell & Co., plumbing	2,200
B. & R. Electric Co., wiring for electric lighting	1,200
W. M. Prall, carpenter work. (The carpenter work was done partly by contract and partly by day labor.)	

Ground was broken in June, 1898, and the building was opened Jan. 2, 1899.

THE ABOLITION OF GRADE CROSSINGS, in Cleveland, O., is being agitated. City Engineer Ritchie says that there are 133 such crossings in the city; and he has been instructed by the Council to prepare plans for their abolition and submit them at a future meeting of the special committee appointed. Plans already prepared for the depression of Detroit St., under the Lake Shore tracks, would call for an expenditure of $185,000. While some of the committee believe that additional laws may have to be passed by the Legislature before the work can be done satisfactorily, others contend that present law requires the railway companies to contribute 65% of the cost of doing away with grade crossings at dangerous points.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER Cleveland, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 299 DEVONSHIRE ST.
CLEVELAND OFFICE, OSBORN BUILDING.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

In ordering changes of mailing addresses, state BOTH old and new addresses; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 329 means that subscription is paid to the 32d week (that is the issue of Aug. 10) of the year 1899; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXII. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

Apropos of our discussion in last week's issue of the reduction in the cost of hauling bulk freights by rail, and the effect of this reduction on waterways, our readers may be interested in an interview with President J. J. Hill, of the Great Northern R. R., published in the New York "Journal of Commerce" of Oct. 28. We quote from it as follows:

President Hill first expressed his views in most emphatic terms on the subject of a deep waterway to the Atlantic and an adequate outlet for the commerce of the Great Lakes, the Transcontinental and Northwestern railway systems contributing thereto. In the first place, he charged the great drawback to the grain trade at present to the exorbitant terminal charges in New York, which he placed at 3 cts. per 100 lbs. on all the grain passing through that port, though concealed in part in the rates of freight from the west, for which he has never been able to discover any services rendered. Grain has been hauled from Chicago to New York this summer, all rail, at 12 cts. per 100 lbs., out of which this 3 cts. per 100 was deducted. If this were removed and New York placed upon a parity with other Atlantic ports, the grain trade of New York would show a large increase. The rate of 1¼ cts. per bushel previously charged at Buffalo has been reduced to ½-ct. per bushel, causing a saving there of $1,500,000 in terminal charges per annum, so that the Buffalo end of the canal had been relieved of this incubus of exorbitant terminal charges. This charge of 3 cts. per 100 at New York is more than the average freight rate existing for some time prior to this year on grain by water from Duluth and Chicago to Buffalo, and this had caused a heavy diversion this season to Montreal over both water and rail routes, one of which latter begins to play a very important part this year, namely, Booth's road from Parry Sound to Montreal. This road is 405 miles in length, and is the shortest route from the upper lake ports to Europe. It has no bonded debt and is able to carry grain at a very low rate with profit. He further said that an enormous grain tonnage goes from Buffalo to New York at 5 cts. to 6 cts. per 100 lbs., all rail, or 3 cts. to 3½ cts. per bushel, out of which these terminal charges at New York of 3 cts. per 100 lbs have to be paid. Eliminating these exorbitant charges at New York the rates by rail are already lower than any canal, small or large, could carry grain for, even if the Erie Canal were deepened to 50 ft.

Continuing, Mr. Hill said that if the State of New York should send $90,000,000 more after the $9,000,000 it lately threw away in enlarging this canal, it would then only ensure cheap transportation for seven months in the year. If the state is prepared to build canals for the maintenance of low rates of freight, it would be far better for it to build a double-track freight railway for that purpose, which could be utilized twelve months in the year; or else agree with roads already constructed to carry freight for a certain toll, either the state or private owners to furnish the rolling stock, or pay toll to existing roads for both the right to use their tracks and for hauling, although he did not advocate this principle himself.

In relation to the Mississippi water route relief, he said the annual appropriation by Congress for improving that river above Keokuk would buy all the steamboats engaged in the Mississippi River trade above that point; and, as for the Mississippi being any longer a serious competitor with the railroads, it was obsolete.

In relation to making a deep waterway capable of admitting large ocean steamers, Mr. Hill did not think that grain would ever go direct through to Europe from the lake ports without one transshipment, which would be more than overcome by the cheaper sailing of smaller vessels through the lake, as the larger lake steamers, already running, were compelled to make a very low rate of speed at many places on account of the damage done to shipping and the channel itself.

We respectfully commend the above clear and emphatic utterances to the careful consideration of the various "waterway conventions" and "commerce conventions" which are being held in various parts of the country.

The Chicago Drainage Canal is meeting with much opposition to the proposal to have water turned in on Dec. 1, 1899. This opposition has come from the city of Joliet and the Illinois & Michigan Canal Commissioners, and now the Special Canal Commission is looming up as ready to block this project at the last moment. In May, the Drainage Board obtained a permit from the War Department authorizing the opening of the canal, but subject to the future action of Congress (Eng. News, May 18, 1899). For months past the Board has been straining every effort to have the work completed before the assembling of Congress, so as to forestall the expected and threatened opposition if the matter should be submitted to that body. The contractors have been granted large extra payments for completing the work ahead of contract time, and some backward contractors have had their contracts cancelled, and their work undertaken by the Board. The latest attempt to block the opening of the canal is quite recent and apparently unexpected. After having made arrangements with the Canal Commissioners for a speedy trial of an important disputed question, and after having granted many concessions to the city of Joliet, in order to prevent the delay due to litigation over other disputed questions, it was thought all opposition to the opening of the canal had been disposed of. But Mr. Isaac Taylor, President of the Special Canal Commission appointed by the Governor of Illinois to see if the work has been done according to the requirements of the law, has recently given out a personal opinion to the effect that these requirements have not been complied with, and that the river cannot carry a sufficient quantity of water for the proper dilution of the sewage. This statement was not made as from the Commission, but only as a personal opinion, Mr. Taylor stating that the Commission had not yet arrived at a conclusion as to the capacity of the river to permit the required amount of water. Nevertheless it is taken as an indication of the purport of the report which will be made by the Commission. According to the statement by Mr. Taylor, as published in the Chicago papers, the application made by the Drainage Board to the War Department, for permission to open the canal, stated that the current created in the river would be at the rate of 1¼ miles per hour. He claims, on the authority of Mr. Desmond Fitzgerald, M. Am. Soc. C. E., Engineer to the Commission, that this current will not give the necessary flow, owing to the limited capacity of the river, in spite of the dredging, removal of obstructions and construction of by-pass, now in progress. The Drainage Board holds that the river has ample capacity for the required flow of 300,000 cu. ft. per minute, with a current not exceeding 1½ miles per hour and, furthermore, that the law gives the Board the right to create a current not exceeding three miles an hour. Conferences between the Special Commission and the Drainage Board, and their engineers, are to be held, and the Board is still hopeful of letting in the water by Dec. 1.

The Joliet opposition, above referred to, has been in the form of attempts to get unusually good terms for the city in the work required for the channel through the city, and the reconstruction of bridges, etc. The demands were raised from time to time, but the Drainage Board always practically acceded to them, the majority of the members considering that it was better to do this than to have the work tied up by the litigation which was threatened. Several members, however, have objected to a continuance of this conciliatory course, and the latest demand on the part of the city of Joliet was only acceded to after some discussion, and on the condition that this should end the series of demands made by the city authorities. This opposition seems, therefore, to have been definitely disposed of. There is still one other source of opposition, however, and that is the Board of Commissioners of the Illinois & Michigan Canal. This barge canal will be in part paralleled by the deep-water drainage canal, but the Commission claims that it must be maintained, one reason given being that it forms a connection with the new Hennepin (or Illinois & Mississippi) Canal. The very doubtful advantages of, or needs for, this latter canal in particular, and barge canals in general, were discussed in our issues of Nov. 24, 1898, and Oct. 26, 1899. In order to maintain the present level of water in the Illinois & Michigan Canal, the Commissioners demand that the Drainage Board shall establish a pumping plant at Bridgeport, but the Board holds that it is under no obligation of law to do this, and that the expense of such a plant is not warranted, in view of the very limited necessity of the old canal. This canal, however, is of importance for political purposes, if not for traffic, and water power rights are also involved. The Commissioners have contracted with Norton & Co. to furnish a certain amount of water for power purposes, and therefore demand that the Drainage Board shall not only establish a pumping plant, but shall maintain it in operation the year round, even after the season of navigation has closed. By agreement between the Canal Commissioners and the Drainage Board, the case is to be tried promptly in the courts. The bill filed in the Circuit Court of Will County asks the Court to restrain the Drainage Board from opening the gates of its controlling works at Lockport in turning water from the end of the drainage channel into the Desplaines River at that point, and from reducing the level of the water in the Chicago River at the point where the same feeds the summit level of the Illinois & Michigan Canal, until it shall make suitable provision for giving the level a supply of water equal to that which heretofore has been used and enjoyed by the canal. It also asks that the Board be restrained from in any wise interfering with or reducing the amount of water in any level of the Illinois & Michigan Canal. The bill states that the Drainage Canal will reduce the surface level of the water in the Chicago River from 2½ to 3 ft. at the head of the Illinois & Michigan Canal, probably destroying the efficiency of that canal, impairing the Hennepin Canal, and making it impossible for the Commissioners to keep their contract with Norton & Co.

The harmlessness of the threat of private water companies to deprive a city of fire protection on account of a disagreement over water contracts has been shown by the Ohio courts. Not long ago, the contract between the city of Urbana, O., and the Urbana Water-Works Co. expired. The two parties being unable to agree on the renewal of the contract, the company threatened to cut off the supply of water for fire protection, and began to dismantle the fire hydrants. This was on Sept. 12. The same day the city secured a temporary injunction against the dismantling of further hydrants, and on Oct. 2 the same court refused to dissolve the injunction. The court held that a

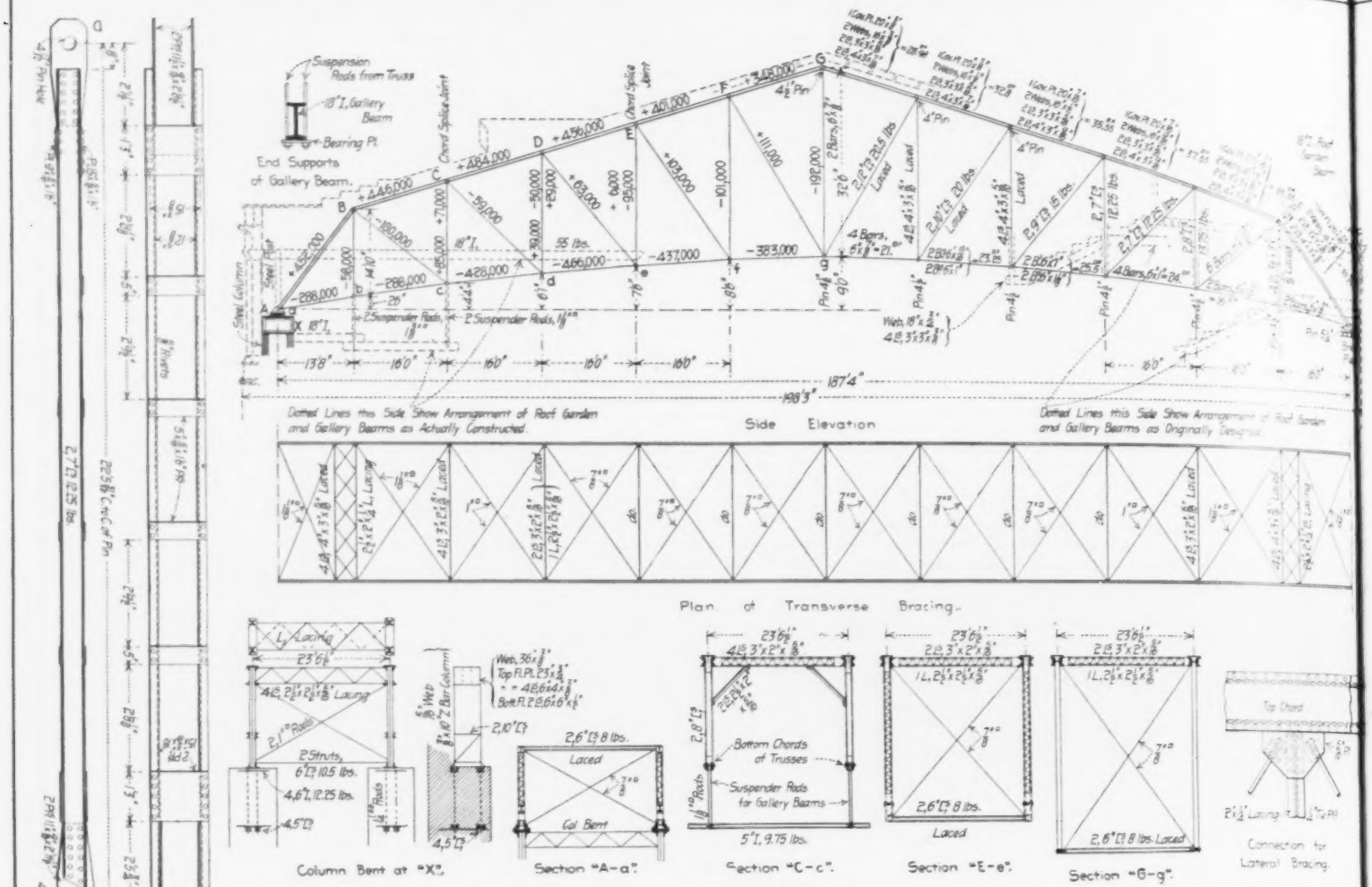

Suspension Rods from Truss
18" I, Gallery Beam
Bearing Pl.
End Supports of Gallery Beam.
Chord Splice Joint
4½" Pin
4" Pin
Steel Column
Dotted Lines this Side Show Arrangement of Roof Garden and Gallery Beams as Actually Constructed.
Side Elevation
Dotted Lines this Side Show Arrangement of Roof Garden and Gallery Beams as Originally Designed.
Plan of Transverse Bracing.
Column Bent at "X".
Section "A-a".
Section "C-c".
Section "E-e".
Section "G-g".
Connection for Lateral Bracing.

FIG. 2.—DETAILS OF MAIN TRUSSES.

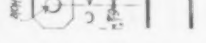


FIG. 9.
DETAILS OF DIAGONAL C—d.

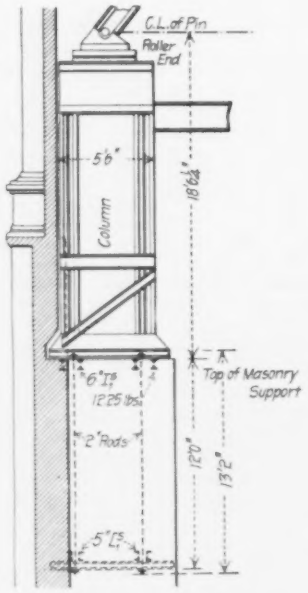


FIG. 3.—STEEL COLUMN SUPPORTING WEST END OF TRUSS.

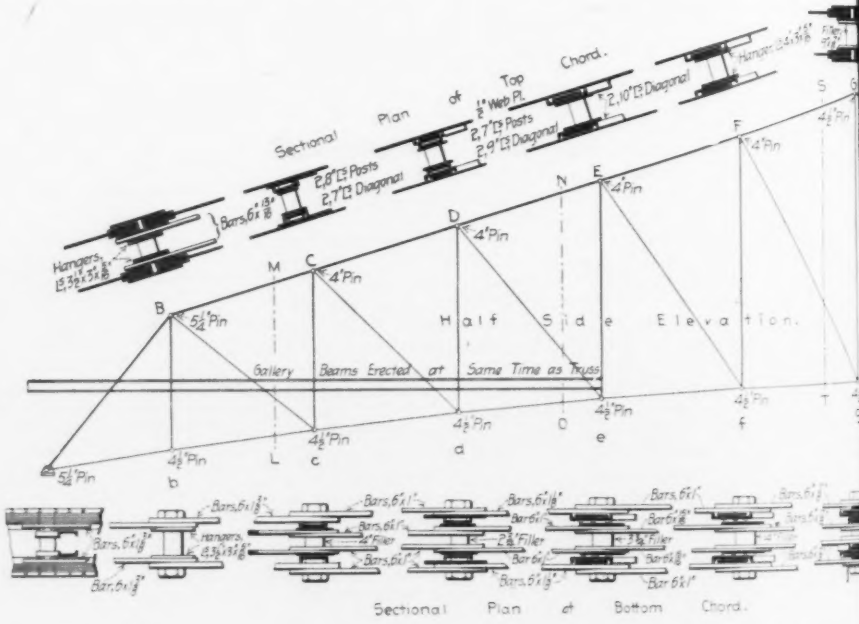

Sectional Plan at Top Chord.
Half Side Elevation.
Gallery Beams Erected at Same Time as Truss
Sectional Plan at Bottom Chord.

FIG. 6.—ARRANGEMENT OF TRUSS MEMBERS.

CONVENTION HALL AT KANS

Frederick E. Hill, Architect. Gillette-Herzog Mfg. Co.,

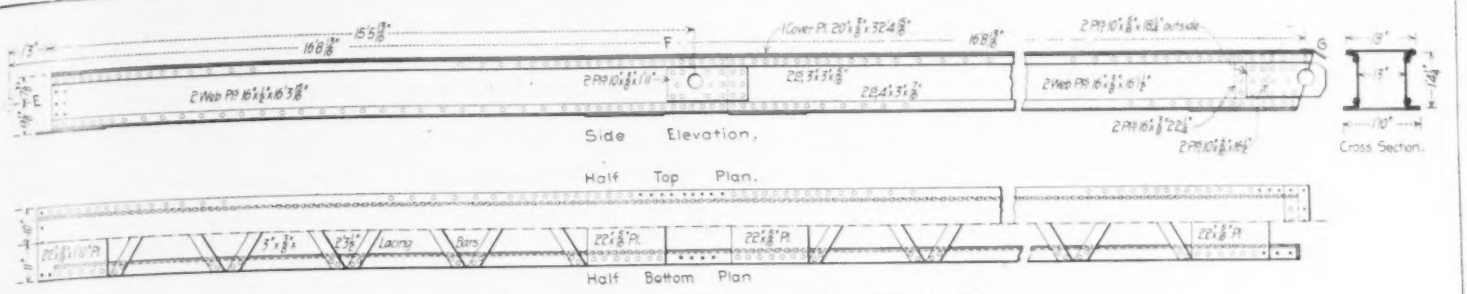


FIG. 7.—DETAILS OF SECTION E—G OF TOP CHORD.

FIG. 4.
VIEW DURING ERECTION.

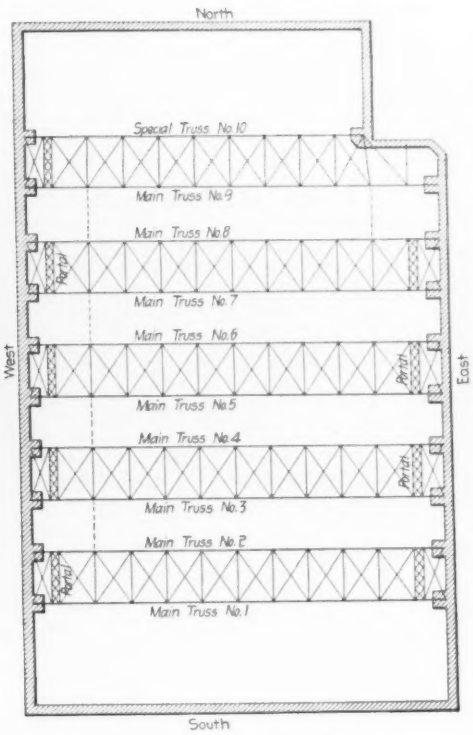


FIG. 1.—GENERAL PLAN.

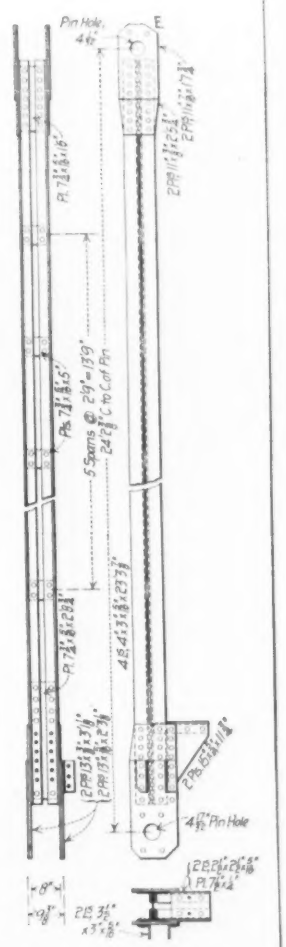
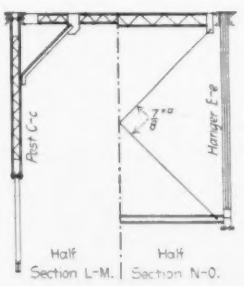
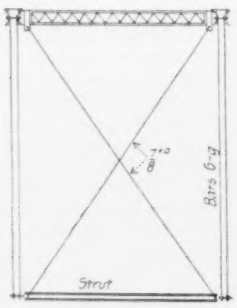


FIG. 8.
DETAILS OF HANGER E—e.





Section S-T.

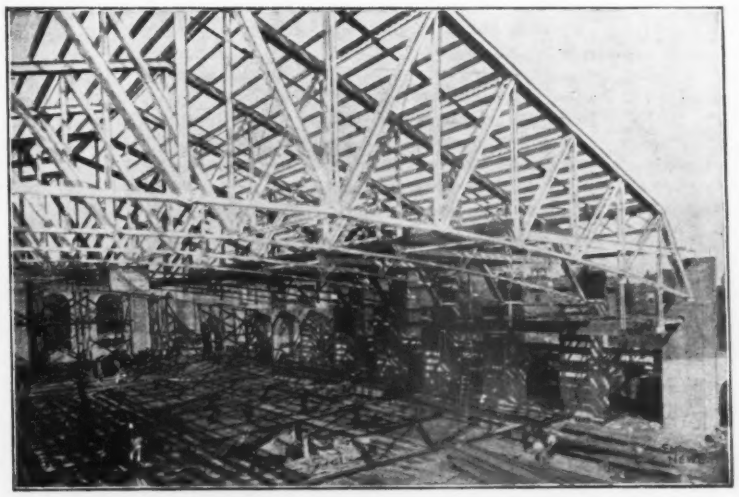


FIG. 5.—VIEW SHOWING COMPLETED ROOF TRUSSES.

HALL AT KANSAS CITY, MO.

Herzog Mfg. Co., Designers and Builders of Structural Work.

company enjoying the use of the streets to supply private consumers could not refuse to supply the city, notwithstanding the disagreements between the two parties. While this is, we understand, a well-recognized legal principle, similar idle threats are often used, and sometimes with success, to bring a city to terms when a contract renewal is pending. On the other hand, and with equal justice, a city cannot escape paying for services actually rendered them by franchise companies, although it may seriously embarrass a company by withholding such payments. Another broken reed, leaned on in this case by municipalities, is the provision for the forfeiture of a franchise on account of the non-fulfilment of some of its conditions. Rarely, if ever, is such a provision of the slightest value, the courts holding it to be against public policy to deprive private consumers of service in this way. As municipal franchises come to be placed on a more rational basis, through a proper system of public regulation of services rendered and rates charged, the serious legal difficulties between municipalities and private companies, now so common, will diminish with gratifying rapidity. The best possible service at reasonable cost, on one hand, and a minimum of risk to capital, with an assurance of a fair return on legitimate investment, is the goal to be striven for. Private companies are beginning to realize this now and to see that unless they act upon some such principles the waves of municipal ownership now rolling over the country will sweep them completely away. This was shown most forcibly at the recent convention of the League of American Municipalities (Eng. News, Sept. 28), where nearly every speaker in support of private ownership assented to some degree of municipal control, while some of them went further and suggested publicity of accounts and municipal or state regulation or limitation of the rates charged to private consumers.

We publish elsewhere in this issue two interesting and valuable papers relating to some live problems in foundry and rolling mill practice which we believe every engineer interested in iron or steel manufacture will do well to study carefully. The longer and in some respects perhaps the more important of these papers is the one on "Practical Microscopic Analysis for Use in Steel Works," by Mr. C. H. Ridsdale, the well-known English metallurgist, and writer on metallurgical questions. As our readers are doubtless aware a great deal has been written during the last few years concerning the microstructure of steel and microscopic analysis. It is much to the credit of these writers and students that they have utilized every resource of the printer's and engraver's arts to emphasize to the general reader the significant structures laid bare by their microscopes. Few or none will probably deny that this work has been productive of much good and that these metallurgists who have bestowed so much time and study on the subject deserve the highest commendation for their labor. It is nevertheless true, as Mr. Ridsdale well says, that the investigations in microscopic analysis of steel so far have been conducted from the standpoint of the physicist rather than that of the practical metallurgist and steel maker in search of something which will enable him to verify and improve the quality of his product. The work described by Mr. Ridsdale is particularly noteworthy for having been directed along just this practical line. It may possibly not be the best that can be done, but it introduces a new departure in the laboratory use of the microscope in steel manufacture, which students of this method of analysis must continue if they wish to develop its greatest practical utility. We believe this opinion will be agreed with by all who will study Mr. Ridsdale's paper in the light of the past work in the same field. It should be stated also that a study of the micro-photographs engraved in connection with the original paper, but which we unfortunately are not able to reproduce, does much to strengthen the statements which it contains. Any of our readers who are interested can, however, doubtless secure these illustrations and the complete original paper by writing to the secretary of the Iron and Steel Institute, Mr. Bennett H. Brough, 28 Victoria St., London, England.

The second paper on "Pig Iron Fractures and their Value in Foundry Practice," by Mr. James W. Miller, takes up a problem more familiar to most engineers. It will be confessed, we think, by the most vigorous opponent of the still common method of classifying pig iron by fracture that the author leaves but little to be added in his condemnation of the practice. That grading pig iron by the appearance of its fracture is a rule-of-thumb method unworthy of the present stage of knowledge of iron smelting is admitted by the most advanced foundrymen everywhere, but it continues probably by the momentum gained from past practice like many of the other common methods of foundry work. Indeed, the materialized spirit of Dud Dudley, which the author conjures up, would find other things besides the grading of pig iron by fracture to rejoice over in its visit to the majority of modern foundries. We believe that lack of information is chiefly responsible for this backward state of affairs in most instances. Our acquaintance with foundry men, even those trained up in the most rigid conservatism of old methods and practice, has shown us that they listen with very earnest attention to all information of new methods and processes which modern scientific investigation is bringing out and are generally eager to seek their advantages when once they clearly comprehend them. The vigorous stirring up of these out-of-date methods of foundry practice, which has been done in the matter of classification by fracture by the paper under consideration, will do a great deal to bring about this improvement.

The International Commercial Congress, held at Philadelphia last week, devoted one day to the discussion of canals. The presiding officer at this session was Hon. Jas. C. Monaghan, U. S. Consul General at Chemnitz, Germany, and he opened the sesssion with a speech, from which the following is extracted:

> Once the Nicaragua Canal is built there can be no question but that it will be a saving to the world equal to $400,000,000 a year. Suppose, then, it does cost $200,000,000, this seems to me to be a mere bagatelle by comparison.

Four hundred million dollars a year is a good deal of money. In view of the fact that the total earnings of all the shipping of the world are less than five hundred million dollars a year (according to Mulhall), our readers can judge for themselves as to the probable accuracy of Mr. Monaghan's estimate, and of his reliability as an authoritative guide. His statement is a fair sample, however, of those which have been freely circulated regarding the Nicaragua enterprise, and which have injured rather than helped it in the minds of intelligent men.

Since the above was in type we have run across another example of glaring misstatement concerning the American Interoceanic Canal in one of the publications of the Philadelphia Commercial Museum. We quote it as follows:

> The greatest need of the manufacturers and exporters of America in their effort to control a fair share of the commerce and trade of the Far East is an interoceanic canal. The importance of either the Nicaragua or Panama enterprise in this trade can hardly be overestimated. To enable American shippers and exporters to land goods in successful competition with the European countries, or even with the great progress and advance being made by Japan, the canal is of first importance. There is but poor prospect of America securing any great share of trade in the Far East until some shorter route is obtained.
>
> Through the Suez Canal, merchants of Liverpool, Bremen, Hamburg and Marseilles, in shipping goods to the Far East, have the advantage of from 2,500 to 3,500 miles and six to nine days' time over American exporters.
>
> If there were an interoceanic canal, New York, Philadelphia, Boston and Baltimore would be nearer by water route than the European cities named to all points north of Hong Kong, such as Shanghai, Tientsin, Kobe, Yokohama and Vladivostock. To cities south of Hong Kong, as Saigon, Singapore, Batavia, etc., the American cities would be on an equality, as far as distance is concerned, with the European cities.

We wish this were true; but unfortunately it is not. The fact is that the Pacific Ocean is in round numbers about 10,500 miles across, from the Central American Isthmus to Hong Kong, and all the ingenuity of man cannot make it any narrower. The distance from New York to Hong Kong will be almost exactly the same by the Nicaragua Canal and by the Suez Canal; in round numbers about 12,500 miles. The distance from London to Hong Kong is 10,000 miles, or 2,500 miles less than the distance from New York. The fact is, therefore, that a ship canal across the American isthmus cannot remove the advantage in point of distance possessed by European ports in competing for Asiatic trade. The Philadelphia Commercial Museums owes it to its own reputation to refrain from giving circulation to statements so absurd and untrue.

MOTOR VEHICLES IN THE STOCK MARKET.

There is a general impression at the present time that the era of the motor vehicle—"the horseless age," as it is glibly termed—is now dawning upon us, and that we are soon to witness some such displacement of the horse in the propulsion of vehicles on common roads as has taken place during the past decade in the street railway field. This idea has been industriously cultivated by the host of articles which have been published in the newspapers and the popular magazines during the past dozen years concerning motor vehicle development, here and abroad. The fertile field thus created for the vender of stock in motor vehicle concerns has been industriously exploited by an army of promoters, until at the present day the principal practical use to which the motor vehicle is being applied in this country appears to be the sale of stock certificates. We hear a good deal of talk concerning the "automobile industry," but at the present time this industry may be fairly estimated as consisting of nine-tenths stock jobbing and one-tenth legitimate manufacturing business. It is a much shorter cut to a fortune to organize a company with a capitalization based on sanguine hopes of future profits and sell its stock to the public than it is to undertake the building up of an organization for the actual manufacture and sale of motor vehicles. The New York "Journal of Commerce," in a recent issue, published a list of 81 corporations organized in connection with motor vehicle schemes, with a total capitalization of $430,900,000. The list included concerns of every sort, ranging from the out-and-out swindlers, who are selling stock in fake concerns without a vestige of value, to the legitimate and honestly conducted manufacturing enterprises, organized to make profits from making and selling motor vehicles and for no other purpose. Most of the concerns named belong to neither of these classes, however. They have more or less tangible assets in the way of machinery, and manufacturing plants, and, possibly, some small business started in the making and selling of vehicles. Added to these are usually more or less assets in the way of patents, "good will," etc., and these latter are made the excuse for swelling the capitalization by hundreds of thousands or millions of dollars, and the stock is then offered for sale to the great gullible public. The promoters of these concerns probably keep within the letter of the law, and they include many men of more or less standing in the business community, but so far as the moral nature of their acts are concerned, we see little difference between them and the out-and-out swindlers above referred to.

At present there are four kinds of motive power which have been used or proposed for motor-vehicles, viz.: Compressed air, electricity from storage batteries, gasoline or petroleum engines and steam engines. Of these four, compressed air has had, thus far, we believe, the most rocket-like career. The total capitalization of the various "air power" concerns in the "Journal of Commerce" list reaches the trifling sum of $85,000,000. There is the much-heralded International Power Co., with its remarkable political backing, capitalized at $8,000,000. This concern is the "parent company" to a miscellaneous lot of "auto-truck" companies with capitalizations of $5,000,000 to $10,000,000 apiece. Our contemporary naively remarks that these latter are to be the "operating companies," but that as yet "they do not seem to have commenced to operate!"

So far as we are informed, this whole scheme for the use of compressed air as a motive power for vehicles for common roads or city streets, is not attested by a single vehicle placed on the mar-

ket, or in actual use, and in fact we know of only a single compressed air wagon ever having been built. The "parent company" has purchased, according to newspaper reports, a few job lots of obsolete manufacturing plants of various sorts from bankrupt concerns; but their usefulness and value in producing live "auto-trucks" is not yet apparent to the naked eye.

It is doubtless entirely practicable to mount some compressed air flasks on wheels, attach a motor with suitable gearing and make a machine that will "go," but it is a far cry from that to a commercial machine, and we have seen so far no evidence worthy of the name that a practical and economical compressed air motor vehicle has been or can be manufactured.

Turning now to electricity, we find an industry on a very different plane. Electric cabs, carriages and delivery wagons to the number of a thousand or more, we believe, are now in actual use in this country. In freedom from noise and vibration, and in ease of control, electric vehicles are admitted to have already approached perfection. There is a very general idea, indeed, and it has been urged even in the technical press, that the electric vehicle is destined to be the prevailing American type of motor-vehicle.

Perhaps this may prove to be the case; but it is well to remember that prophets who go off at half-cock do not always hit the mark; and, further, that the electric vehicle has some inherent drawbacks. These are the high first cost, the dead weight of the storage batteries, the expense due to their maintenance, and, finally, what may be best described as the "general cussedness" of this system of storing energy, with its objectionable fumes, its occasional sloppiness and its limitations of output and dependence on a central station for recharging. The electric carriage can be made an excellent pleasure vehicle for the wealthy. The demand for it has been stimulated by its adoption as a fad by the ultra-fashionable during the present year. But fashions change; and for the rich man's private carriage, horses are not likely to be permanently displaced by any form of mechanical motor.

The real question concerning the electric vehicle is whether it can compete in dollars and cents with other forms of mechanical motors. The market for pleasure carriages and swell delivery wagons at $2,000 to $3,000 apiece, is a mine which will soon be worked out.

Turning now to the capitalization of these electric vehicle concerns, we find that their promoters have been more imbued with the ideas of the eminent Col. Mulberry Sellers than even the gifted "auto-truck" boomer. First we have the Electric Vehicle Co. (capital stock $12,000,000). This is twisted up in some sort of relation with the Electric Storage Battery Co., capital stock, $18,000,000; the Columbia Automobile Co., $3,000,000; and the Columbia & Electric Vehicle Co., $5,000,000, and the snarl is about as puzzling to unravel as the bond issues of the Reading Railroad. We gather, however, from the statement in the annual report of the Electric Vehicle Co.'s president that the last-named concern is a manufacturing organization for whose machines the Electric Vehicle Co. are the sole selling agents. We also glean some interesting information as to the cost of production of electric vehicles from the following paragraphs in the report:

> By means of this manufacturing organization the Columbia & Electric Vehicle Co. is in a position to furnish during the coming year an output of at least 8,000 automobiles, representing at present prices a gross business of about $20,000,000. The exclusive right to purchase the entire output of the Columbia & Electric Vehicle Co. is assured by contract to the Electric Vehicle Co., which thus becomes the sole agency for its disposal. * * * *
>
> By its half ownership of the stock of the Columbia & Electric Vehicle Co. the Electric Vehicle Co. becomes entitled to one-half of the profits of manufacture, which in all cases are fixed at 20% above cost, making the profit accruing to the Electric Vehicle Co. 10% on the entire product.

Now 8,000 machines for $20,000,000 means an average price of $2,500 each. Of this, we are told, 20% is profit; hence the manufacturing cost must be 80% of this, or an average of $2,000 per vehicle. Very good steam and gasoline carriages are now on the market with list prices—not manufacturing costs—of $600 and $1,000, respectively. This looks like pretty strong evidence that the electric vehicle is going to be under an enormous handicap in its competition with vehicles propelled by other motors.

Of course manufacturing costs will probably be reduced somewhat in the future; but a reduction so radical as to enable the electric vehicle to compete in first cost with its rivals seems improbable.

The great feats of the Electric Vehicle Co. in high capitalization have been performed in connection with its action as a "parent organization" to local "operating companies." These are the New York, the New England, the Illinois and the New Jersey Electric Vehicle Transportation companies, the first three capitalized at the trifling sum of $25,000,000 apiece. These remarkable corporations are alleged to have paid cash for the exclusive right to purchase and operate the vehicles sold by the Electric Vehicle Co. The President's report says that these concerns "have been placed on a business footing," which sounds well at least. The "Journal of Commerce" notes that at the time these corporations were organized the "parent company had in all only about 110 of the new carriages in operation."

It is instructive to reflect in connection with the above figures of capitalization, that neither the Electric Vehicle Co. nor any of its subsidiary corporations have any monopoly of the manufacture and sale of electric motor vehicles. Other concerns are now manufacturing and selling such vehicles, and we know of no evidence that they are not just as good and as cheap as those turned out by the hundred-million-dollar combination. Under these circumstances the stock buying public may be pardoned if it looks cross-eyed at these $25,000,000 "operating" concerns, and even raises one eyelid at their $12,000,000 parent.

Turning now to the vehicles propelled by some form of internal combustion motors, we find a large number of concerns in our contemporary's list, There are three $25,000,000 corporations, and then follow two of $10,000,000, one of $8,000,000, eight of $5,000,000, and so on down to $100,000 concerns. We may remark parenthetically that very likely some of these modestly-capitalized concerns may have more actual assets and better prospects of future profits than some of the concerns capitalized at ten or twenty times as much.

The internal combustion motor, using some form of petroleum distillate as fuel, has now been on the market for several years, both here and abroad. Vehicles propelled in this way can be built and operated at reasonable cost, and when well designed and constructed they prove quite satisfactory. Their chief disadvantages as pleasure carriages are their noise and vibration and the objectionable fumes due to the incomplete combustion of the fuel in the cylinder. No concern has or can secure any monopoly in the construction of vehicles of this class, and competition in their production is pretty certain to keep manufacturers' profits down to a reasonable figure, and possibly to a figure unreasonably low. Certainly if any considerable percentage of the concerns in the "Journal of Commerce's" list should actually engage in business on a scale proportioned to their capitalization, the market would be greatly overstocked, and the selling of machines at cost or below would destroy the chances of profit for all the concerns.

Concerning the fourth class of motor-vehicles —those propelled by steam—it may be said that at present a revival of interest is being witnessed in this field, and a number of very promising vehicles of this class are or are soon to be on the market. Many engineers are of the opinion that the steam engine has the best prospect of success of any motor for use on common roads, and the excellent performances of some of the recent steam-driven vehicles gives much support to this belief. It is to be noted also that thus far the steam vehicle promoters seems to have been less afflicted with the big head in capitalizing their schemes than the promoters of other classes of motor vehicles, and to that extent at least they are deserving of public confidence as compared with their rivals with the $25,000,000 hat.

Of course it must be understood that there is as little prospect of any monopoly being created in steam vehicles as there is in electric or gasoline vehicles. There are probably a dozen different ways in which a successful steam motor-vehicle may be built. The field of motor-vehicle construction, moreover, has been so thoroughly exploited by inventors that any patents now obtained are almost certain to be of exceedingly limited scope.

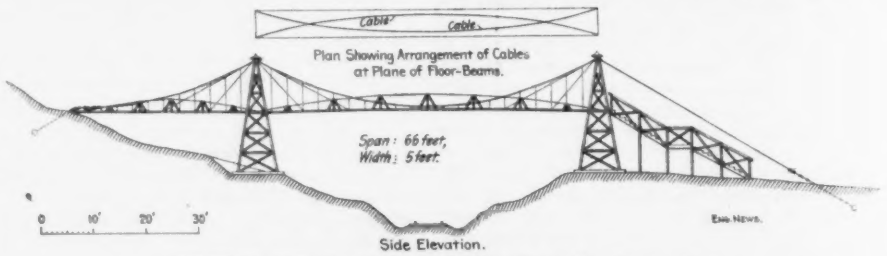
We had occasion recently to warn the public against all investments in concerns claiming a monopoly of liquid air manufacturing except when guided by the disinterested advice of a competent engineer and a competent patent attorney. From the above review of the status of the motor-vehicle industry it seems clear that the same course is the only prudent one to follow with respect to investments in this field. There are opportunities for the building up of profitable enterprises in this new industry, but it can only be done by the same course of intelligent and honest management which creates success in other fields. Investments in such concerns will be attended with satisfactory results; but those who buy the rest of the 430 odd millions of paper capital of the motor-vehicle industry are likely to possess little but paper in the end.

LETTERS TO THE EDITOR.

A Novel Footway Suspension Bridge.

Sir: We enclose herewith a blueprint of a small suspension bridge that we are now erecting for Mr. Henry S Kip, at Rhinebeck, N. Y. Though of exceeding simplicity of design this bridge has several novel features, which the writer believes are his own ideas. The elevation shows what we think is a new application of the up-turn rope to prevent the wind from lifting the bridge. The up-turn rope also answers the purpose of a railing. In a similar manner we have made use of the catenary curve, to take the horizontal wind pressures. Starting at one corner of the bridge, in the plan view, and stretching a rope in a catenary curve, fastening it to each floor beam, at the points of intersection, and back to the other corner of the same side, then doing the same on the other side, takes care of the horizontal wind pressures. Some time ago the "Engineering Record" published a short article on an all-rope suspension bridge. The lower cables that were put in to prevent the bridge from lifting, were deflected 1 ft. This allowed the bridge if the wind got underneath to rise 2 ft. By our method of using the up-turn cable, we prevented absolutely any rise at all. On a small bridge like this the undulation does no harm, and the expense of trussing is saved. Yours truly,

Star Engineering Co.,
Karl Wegmann,
New York, N. Y., Sept. 15, 1899. Assistant Engineer.



FOOTWAY SUSPENSION BRIDGE AT RHINEBECK, N. Y.

The Organization of Railway Engineering and Maintenance of Way Departments.

Sir: I want to compliment you on your article in Engineering News of Oct. 19, especially your conclusions as given on p. 259. The conclusions are eminently sound, though the premises I think faulty, in that the conditions that you decry are exactly the conditions that exist. My acquaintance with maintenance of way engineers is quite extensive, though not comparable with yours, but I con-

fidently challenge finding among them more than exceptional instances of practical familiarity with track work. In location and construction, the setting of grade and line stakes, the computation of contents, and kindred subjects, they are expected to be masters, but "Maintenance of Way" is "unmitigated mechanics," associated with drudgery and constant elemental exposure.

The young fellows, well born, with the instincts of gentlemen, given exceptional educational advantages, adopting railway engineering as a profession, expect to pursue it in a gentlemanly way, and hence their reliance upon a drawing board and a mathematical demonstration, when the problem is really one of mechanics and mechanical exactness, always distasteful to these gentlemen, approaching undisguised contempt for the "mere mechanic."

I am old enough to have been associated with early engineers, like John B. Jervis and Horatio Allen, practically self-taught men, and consequently compelled to be originators. With our present facilities for the highest training, I have urged for many years, as you do, that we ought to have the ablest body of trackmen in the world. This is to be accomplished only by the rigid enforcement of the rule, that charge or supervision of maintenance of way will not be given to any man who is not expert in all its mechanical details.

This means early and long hours, manual labor, with the accompanying grease and dirt, but the candidate emerges knowing what he never could have learned from the rear seat of a coach, and his daily notes of dissatisfaction to his foremen would thereafter be tempered by a knowledge of what the poor devils have to hopelessly contend with. I do not believe either of us will be here long enough to see this accomplished (though it will come eventually), for the present system is too strongly entrenched, and is protected by the absence of knowledge of this department among higher powers. I believe, however, that we are slowly persuading the maintenance of way departments that they really ought to know what their work costs.

Very truly yours,

Oct. 21, 1899. E. G. P.

A Sure Cure for the Jigger Pest of South America.

Sir: My brother reports to me from Ecuador (Guayaquil & Quito Railroad Engineer Corps) the absolute cure (death of the insect and of the eggs) of wounds by this insect with 10% solution of iodoform in collodion. Those of the corps whom he treated with this remedy were not incapacitated. Those who did not use it were disabled. The following facts may be interesting to your readers:

This insect, Sarcopsylla pene Prans, belongs to the group of wingless diptera known as pulicidæ, and is closely allied to the common flea. It has been known for more than a century in South America and the West Indies, and is said to have been introduced to the West Coast of Africa in the sand ballast of a ship from Brazil in the middle of the present century. It spread slowly in West Africa for some years, until Stanley's expeditions and the spread of civilization carried the pest widely over the Congo Free State, and it had crossed the continent as far as Lake Nyassa in 1891, and in 1894 it reached the Shire Highlands, and arrived on the East Coast in the following year.

During the last few months cases have been detected in Coolies returning to Bombay from British East Africa, and precautions for examining all such persons and disinfecting the ships which have carried them are now being taken, and are fully justified by the descriptions of the ravages and sufferings caused by this insect, which are as follows: Sir Harry Johnstone, of British Central Africa, describes it as a small flea, only just visible to the naked eye, the female of which burrows under the skin, usually of the foot, swells up in a few days to the size of a pea, and then lays a large number of eggs, several hundreds in number. The mother then dies, but the young soon hatch out and burrow in all directions, causing extensive ulceration and not infrequently gangrene. Within the first few days before the female lays its eggs it can be detected and extracted without difficulty, and a little carbolic acid dissolved in sweet oil (1 in 24 parts) dropped into the hole will allay the irritation and kill any eggs which may have escaped.

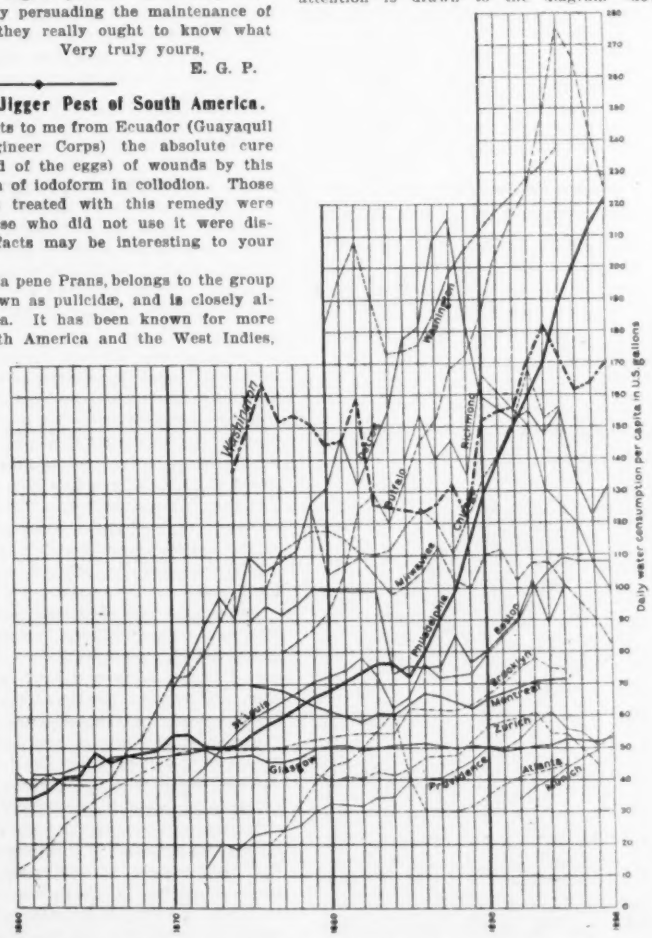
Mr. Lionel Decle, in his book "Three Years in Savage Africa," describes a village in which not a single man, woman or child was free from dreadful ulcers caused by this parasite. Boots afford some protection, but Europeans in affected tracts should have their feet examined by a native servant twice a day and the jiggers removed when still small, from two to four being usually taken out daily. Among natives they cause great damage, half of a troop of soldiers or carriers being often rendered totally unfit for service by this disease. Sandy soil is most suitable to their development. Dogs, monkeys, fowls, some birds (parrots) and mice are attacked by them and may serve to spread them to new places. As many as 280 have been taken out of a boy's body at one time. Iodoform seems to be of the greatest value in the treatment of the ulcers produced by jiggers, while kerosene oil is recommended as a disinfectant.

Albert S. Ashmead, M. D.

65 W. 12th St., New York, Oct. 30, 1899.

Relative Consumption of Water per Capita in Washington, D. C., and Philadelphia, Pa.

Sir: In the Engineering News of Oct. 5 there appears a partial synopsis of the report of the Commission on the Improvement of the Philadelphia Water Supply, in which attention is drawn to the diagram showing the per capita water consumption of various cities, and pointing out the fact that the present consumption of Philadelphia is only exceeded by that of Buffalo, N. Y., and Washington, D. C. I do not know what authorities were consulted for the data in the diagram mentioned, but as far as the consumption of the city of Washington is there shown they do not agree at all with the records of this office. These records are complete as far back as 1874. I have plotted them on the diagram. The discrepancy is apparent. The original curve of the diagram shows the consumption to be from 40 to 80 gallons in excess of the record. Although Washington is an extravagant user and waster of water, it is not as bad as represented on the original diagram.



Very truly,

A. M. Miller,
Lieut.-Col., Corps of Engineers, U. S. A.,
In Charge of Washington Aqueduct.

Washington, D. C., Oct. 6, 1899.

(We referred the preceding communication to Mr. Rudolph Hering, M. Am. Soc. C. E., the chairman of the commission, and have received the following letter in reply.—Ed.)

Sir: Mr. Rudolph Hering, Chairman of the Commission appointed by the Mayor to investigate the Philadelphia water supply, to whom you referred the above letter from Colonel Miller, is out of the city, and has asked me to state the facts in the case, as these data were among those compiled by me for the use of the Commission. The population used in the data quoted by Colonel Miller is that for the entire District of Columbia, and is made up as follows:

	1880.	1890.
Washington, old limits	147,293	188,932
Georgetown, old limits	12,578	14,046
Remainder of District	17,753	27,414
Totals	177,624	230,392

As only Washington and Georgetown are supplied by the water-works, it is not proper to use the population of the whole District in computing the per capita consumption. In Washington and Georgetown there are a great number of premises that depend for their water upon wells and pumps. No official cognizance is taken of these, but their number is very large. There are also, at the present time, perhaps 150 or more public wells in use in Washington; there were 270 such in 1890, and 170 in 1896. It therefore seemed, in the writer's opinion, that the per capita consumption based upon the population of Washington city alone would be as near the truth as could be approximated with the data at hand. This population was used in deducing the curves printed in the Commission's report.

The curves given in the diagram referred to are merely illustrative of the progressive rate in growth of the per capita consumption of cities as they increase in size. They had no bearing on the question of establishing the amount of water to be allowed in the Philadelphia estimates. This was derived in an entirely different manner.

Very truly yours, James H. Fuertes.

100 William St., New York, N. Y., Oct. 23, 1899.

Notes and Queries.

W. S., Sioux City, Iowa, asks if there is published a "Star Map" suitable for practical field astronomical work. We refer the query to our readers.

PIG IRON FRACTURES AND THEIR VALUE IN FOUNDRY PRACTICE.*

By James Williard Miller.

In a paper entitled "The Yard Grading of Pig Iron," read in December, 1898, before the Foundrymen's Association of Pittsburg, Dr. William B. Phillips, editor of the "American Manufacturer and Iron World," and one of the best-known chemists in America, gives a curious account of the present method of grading pig-iron. Of course, like many of the good things in the iron and steel world, the method of grading pig-iron originated in Great Britain several hundred years ago. Dud Dudley, in his petition to King Charles I. in 1660 on the subject of the manufacture of pig-iron,† states that there were then made three kinds of iron, to wit, in the original words:

> The first sort is Gray Iron, the second sort is called Motley Iron, of which one part of the Sowes of Piggs is gray, the other part is white intermixt; the third sort is called White Iron; this is almost as white as Bell Mettle, but in the Furnace is least fined, and the most terrestrial.

The author goes on to say:

> I may take occasion here to speak of the Nature of Coldshare Iron, which is so brittle, if made of the grain Oare or Ironstone, would be almost as brittle as some Regulus Antimonii made Iron, for with one small blow over an Anvil you may break the biggest Bar that is, if it be perfect coldshare Iron—nay, the plough-man often breaks his share-point off if it be made of coldshare Iron. But perfect tough malliable Iron will not break feasibly in hot-heat or cold, as coldshare will, or red-hot as Sulphurious veneriated redshare Iron will, but yet tough enough when it is cold. All of which aforesaid qualities of Iron the Authour well knoweth how to mend their Natures, by finning or setting the finery lesse transhaw more burrow, which are terms of art, and by altering and pitching the works and plates, the fore-spirit plat, the tuiron, bottome, back and breast or fore-plate, by the altering of which much may be done, if the work be set transhaw and transiring from the blast, the Iron is more coldshare lesse Fined, more to the Master's profit; lesse profitable to him that makes it into manufactorage, and lesse profitable to him that useth it, but the Iron made in a Burrow work becometh more tough and serviceable; yet the nature of all Ironstone is to be considered, both in the Furnace and in the finery, that the Sulphurious Arcenical and Veneriating qualities, which are oftentimes in Ironstone, be made to separate in both the works from the fixed and fixing bodies of Iron, whose fiery quality is such that he will sooner self-calsine than separate from any Sulphurious veneriated quality.

This is the earliest recorded attempt to grade pig-iron on the yard, and passed as the most scientific description that had yet appeared. Since that date we have drawn away from the "arcenical veneriating" quality of pig-iron, and have substituted cold-short for cold-share iron, but in other respects the description might be used to-day. If the spirit

*Abstract of a paper read before the Iron and Steel Institute of Great Britain.

†"Metallum Martis," 1665, reprinted in the "Journal of the Iron and Steel Institute," 1872, No. II., p. 227.

of Dud Dudley could make the rounds with a pig-iron breaker and grader, he would feel perfectly at home, and would rejoice that the art which he founded two hundred and forty years ago had not progressed much beyond its original lines.

Dud Dudley was satisfied with three grades of iron, whereas six grades are now universally recognized, which, however, cover the ground but little better than did Dud Dudley's three grades—in fact, not so well. In the youngest district in America, where now about 30% of all the foundry iron in the United States is made, thirteen distinct grades have been established, still leaving room for more. The grader, in conscientious sorting of the iron into its different grades, ever and anon runs against a fracture that fits neither grade so far established; hence a temptation to form a new one.

In the beginning of ironmaking in the district referred to, Alabama, before the nature and condition of the ore and fuel became understood and regulated, the furnaces working under unsettled conditions, operated by green hands from the cotton-fields of Alabama, and directed in many cases by inexperienced managers, who would probably set the blast too much "transiring" or not enough "transhaw," produced iron which would not fit into any of the six existing grades. The conscientious grader, to cover the ground, therefore, added four more regular grades to the six existing, viz., No. 1 silvery, No. 2 silvery, No. 1 soft, No. 2 soft, making ten in all, and still the ground was not satisfactorily covered. No. 4 foundry had to fill the gap between grey forge and No. 3 foundry, caused by the decreasing demand for puddled iron, and to cover the ground more thoroughly, the grades of No. 1 X, No. 2 X, and No. 3 X were inserted between the regular numbers, making fourteen grades in all, with which the manufacturer is burdened, by which the consumer is confused, and over which both wrangle, and which never was a true measure of quality, and therefore never can be a satisfactory one.

The fracture of pig-iron is a delusion and a snare. There is not one man in ten, whether consumer or producer, that can tell by the fracture a pig of iron suited for car-wheels from one fit for stove-plates. Where is the line of demarcation between succeeding grades? What is the difference between an open No. 3 and a close No. 2, for example? No matter how carefully the grading is done, there must be, by the very nature of things, in every grade some pigs closer than others. There is, therefore, always room for contention, even when both sides are trying to be fair, which is not always the case.

The fact is that nearly every pig of iron varies in grade from one end to the other. Not infrequently you can show up three distinct grades in one and the same pig. The sow, if at all heavy, is invariably from half to a whole grade higher than its pigs. Is the iron in the sow therefore of a better quality? This is hardly reasonable; yet there is a difference in price from 1s. to 3s. The value of an iron, therefore, does not depend upon its fracture, nor is the fracture any guide as to the special purpose for which a certain iron may be best suited. It is only an indication of the condition of the furnace that produced it, and not an altogether trustworthy indication of even that. The principal factor that determines the grain in the fracture of cast-iron is the time given it to pass from the liquid to the solid state. No one is better aware of this fact than the foundryman. Of two castings poured from the same ladle, the lighter casting is invariably the closest grained. The degree of hardness resulting in a casting is not determined by the fracture of the pig-iron, but entirely by its chemical composition and the rate of cooling.

The greatest drawback to the practical application of chemistry in the foundry is that with cast-iron in the sand in the ordinary way it is almost impossible to get shipments of uniform composition. This is due to the fact that the iron as it flows from the furnace is very irregular; and it not infrequently happens that there is a difference of 1½% in the silicon from the first to the last bed in a cast of iron of practically the same grade. This difficulty will be entirely overcome when the old method of casting in sand beds, which, like the grading of iron by fracture, has been but little improved upon since Dud Dudley's time, will have been superseded, as it is bound to be, by the more economical and rational method of mechanical handling. Running the metal from the furnace into a large receptacle of 20 or more tons capacity will ensure a perfect mixture of that amount, which can be analysed and piled or shipped as what it is with certainty. The time required to transport molten metal from furnace to the machine allows the slag to separate more thoroughly, and an appreciable amount of the sulphur also escapes. The iron is not contaminated by a crust of sand or loam. The producer will know what he has to sell, the purchaser will get what he buys, and the consumer will not have to handle and remelt a lot of sand and scruff, which costs extra fuel and is liable to contaminate the product.

When the blast-furnace owners and managers have come to the conclusion that the evils which they suffer from, and which they are held accountable for by the foundrymen, can be obviated, if not entirely obliterated, by grading iron in the proper way, then grading by fracture will no longer be the basis of quality and price, and the most prolific bone of contention between the producer and consumer of pig-iron will be removed. Another object which can be accomplished when this comes to pass is that the producer of pig-iron can avail himself of some one of the mechanical methods which are rapidly coming to the fore, thus proving beyond doubt that their use is mechanically practicable and commercially profitable to the pig-iron maker in the handling of his product. He will be benefited by a lower cost in the manufacture of his product and by an increased value of the product itself. It is admitted by every man who knows the facts that if iron can be handled from the furnace to the stock pile by mechanical means without having to be cast in sand, you have got a product which is worth more money than if cast in the usual way. Furthermore, the foundryman himself will be benefited to an extent that he is at present perhaps not conscious of. I am not prepared to give the exact facts regarding some experiments which have been made in the United States lately in the use of sandless iron in foundry-work, but I am informed from reliable sources that these experiments show a decrease in fuel cost, and a distinct saving in bad and imperfect castings, and that more iron can be melted in a given time.

I am not here to advocate the adoption of any particular method of mechanical casting; that is a matter which each man will decide for himself, taking into consideration the output of his furnaces, the condition under which his product must be handled, and the wishes of his customers. It is only necessary for me to state that in the United States large concerns engaged in the manufacture of agricultural machinery buy sandless iron solely on chemical analysis and not by fracture; and in conversation with the managers of those concerns, they have informed me that they know for a fact that the chemical analysis of the material which they put into castings of their machinery helps them to gage the cost, and gives them a basis from which to calculate the strength necessary for different parts much better and more economically than when they bought their iron and melted it, depending on fracture.

Furthermore, iron cast by mechanical means has to-day among people who have used it a preference over that cast in sand, and a particular establishment I have in mind in making the above assertion is one of the best-known foundries in the United States, at which they have used sandless iron exclusively for a period of over eighteen months, and the assertions made above are derived from the foreman of the foundry department after a careful tabulation of results obtained.

THE LANSTON TYPESETTING AND CASTING MACHINE.

The latest successful claimant for support in mechanically composing and casting type for the printer is the Lanston "Monotype" machine, which is illustrated in the accompanying cuts. This machine is an American invention, and is in successful use in this country and also in Europe, the New York "Sun" being one of the leading American newspapers whose composition is done by it. As many of our readers doubtless know, the successful composition of printers' type by mechanical means is a comparatively recent invention, when we take into account the fact that typesetting was a well-established art when Columbus discovered America. The development of composing machinery was briefly outlined in our issues of April 9 and 21, 1892, when we also described in detail the then new Mergenthaler, or "linotype," machine, which was at that time and is still employed for setting the type for Engineering News. Since this description was published the linotype machine has come to occupy the foremost place among mechanical composing machines in the extent of its use by printers, and with each succeeding improvement its flexibility and accuracy for all kinds of typesetting have increased so much that successful rivalry has become an exceedingly difficult task. In the new monotype machine, however, it is claimed with much reason that a successful rival has finally been developed, and we accordingly present our readers with a description and illustrations of the new invention.

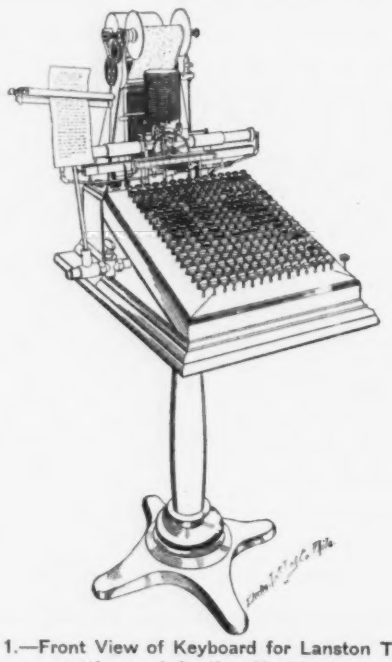


Fig. 1.—Front View of Keyboard for Lanston Typesetting and Casting Machine.

The Lanston monotype machine, like the Mergenthaler linotype machine, is primarily a type-casting machine, but with the radical distinction in this respect that it casts each letter, point and sign, including the spaces, separately. In the linotype all the characters, including the spaces which make up a whole line, are cast at one time in a single solid piece. This difference, it will be seen, makes it possible to knock down the type set by the monotype machine, and to distribute the characters for re-use, just as is done with ordinary hand-set type, or, as is more usually done, the type can be knocked down and remelted to be used over and over again. The casting of single types instead of a solid line of type is, then, the fundamental distinction beween the monotype and the linotype machines. With this point distinctly understood we can proceed with the description of the monotype machine.

The Lanston monotype machine is constructed in two parts, viz., a keyboard and a type-casting machine. The keyboard is entirely separate so far as space, time, or the limitations of the operators are concerned from the type-casting machine, and its external appearance is clearly shown by Fig. 1. The sole function of this keyboard is to punch a series of holes in a moving strip, or ribbon, of paper, which is unwound from one spool onto another, passing under a series of punches in its journey. These punches are operated by striking the keys on the keyboard, two holes being punched for every stroke of the key. The whole bank of keys comprises all the characters in the fount of type used, and three sizes of space type. In operation, therefore, the operator strikes one key after another, according to the sequence of the characters in the copy, and to secure the necessary spacing between words he strikes at the end of each word the space type key. As each key is struck it punches, as stated before, two holes in the paper ribbon. One of these holes registers the number of the vertical row in which the key stands on the keyboard, and the other hole registers the horizontal row.

Simultaneously with the making of the perforation in the paper ribbon, a registering scale on the keyboard charges to the line being set an amount equal to the body width of the type just selected and perforated. In this way a line of matter is progressively perforated and charged up, until, as the end of the line is approached, which is indicated by a tell-tale bell, and is shown exactly by the line scale, it is seen that the whole of the next syllable or word is inadmissible to that line. At this point another part of the registering scale discloses the amount of unoccupied space in the line just perforated. If this space is great enough to include all but a character or two of the next syllable or word, it is evident that it is better to make room for the overrunning letters by narrowing slightly the spaces between the preceding words. If, on the contrary, the unoccupied space is too small to include more than one or two letters of the next syllable or word it is better to hold it for the next line and to fill out the unoccupied space by widening slightly the spaces between the preceding words. Knowing the unoccupied space to be filled, the operator now needs only to know the number of spaces between the preceding words, and this has been kept count of by still another part of the registering scale.

The registering scale on the keyboard thus shows the operator, first, the space which has to be made up by increasing or decreasing the widths of the space types, and, second, it shows how

many space types there are to apportion this decrease or increase among. To illustrate by a concrete case: A line of type fails to fill the line by 1-10-in., and there are ten space types between the words of the line. It is clear that if the body width of each space type is increased by 1-100-in. the line will be filled or justified. Again, if the line of types is 1-10-in. too long, it is clear that by decreasing by 1-100-in. the body width of each of

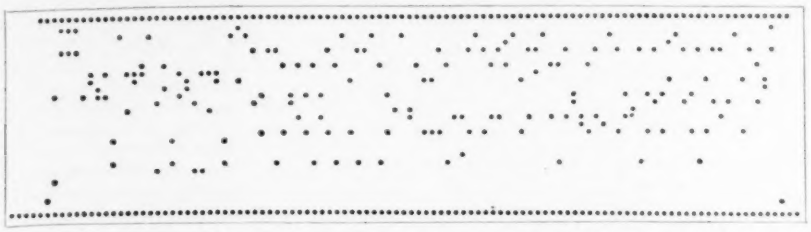


FIG. 2.—FAC SIMILE REPRODUCTION OF PERFORATED PAPER RIBBON, LANSTON TYPESETTING AND CASTING MACHINE.

the ten space types the line would be justified. The reading of the scale figures shows the operator the change necessary in the normal space types to justify the line, and a series of justifying keys enable him to make this change. These keys, like all the others, operate punches which perforate holes in the paper ribbon. Fig. 2 shows the appearance of a section of the ribbon as it comes from the keyboard. In this drawing the rows of regularly spaced holes at the edges are merely guide holes by means of which the paper ribbon is advanced over sprocket wheels; the smaller holes in the body of the strip represent the characters or letters, and the larger holes toward the bottom are justifying holes. Now as the justifying holes are the last ones to be punched in each line, it follows that the types making up this line cannot be set in their ordinary reading progression, but they must be set backwards for the reason that the justification of the line must be carried out before, and not after, the line is set.

The foregoing describes briefly the operations at the keyboard. The result of these operations, it will be seen, is a roll of perforated paper ribbon. This ribbon, when fed to the casting machine, initiates and controls all the operations which produce the cast type set up in column widths ready to take printed proofs from. The manner in which the ribbon acts to accomplish this will now be explained. Corresponding to the characters on the keyboard there is in the casting machine a case of matrices or molds of these characters. As the paper ribbon passes through the casting machine the matrix case is made to travel so that the matrices of the characters represented by the perforations in the paper are brought exactly to the center of the casting mold. The travel of the die is controlled by a pneumatic device which is put into operation by the two holes pierced in the paper for each character, the hole recording the vertical row of the character causing the movement of the die case in one direction, and that recording the horizontal row causing a movement at direct right angles to the first movement, the die case being mounted on a compound slide, the parts of which move only at right angles to each other. Each of these reciprocal movements is so restricted that the desired matrix is centered over the casting mold. To accomplish this a number of stops are provided in the path of each of the two movements. These stops are operated by compressed air admitted to the corresponding pistons through channels which are closed by the paper ribbon, except where the ribbon is perforated. The location of the perforations determines which of the stops is to be brought into operation, and thus commands the position in which the case or plate of matrices is retained immediately before the type is cast.

After the matrix case has been arrested in position by the means described, it is accurately centered over the casting mold by means of a taper-plug entering into one of the centering holes, which are located on the reverse side of each matrix. Being centered over the mold, the matrix is depressed to form a tight joint, and the type metal is forced through a nozzle at the foot of the mold, filling it and the matrix, to form the body and face of the type together, the type, when cast, thus being on its feet. The casting mold is closed on three sides, the fourth side being a movable blade, which, by means of a wedge, is made to accommodate the mold to the exact set width of the type character, by the movements given to the die plate. The molten metal, carried in a pot and kept molten by Bunsen burners, is projected under pressure to the face of the matrix, and this pressure is maintained until the mold is filled so that there may be no danger of the metal leaving the face of the matrix. The jet of metal is cut off after the cast is made and the type being chilled by a stream of circulating water, and the mold opened, the now-finished types are transferred by mechanical carriers to the galley. The types are held positively during the whole of their travel, and also until the line is completely cast and transferred to the galley, when the carriers advance to receive the next line of type.

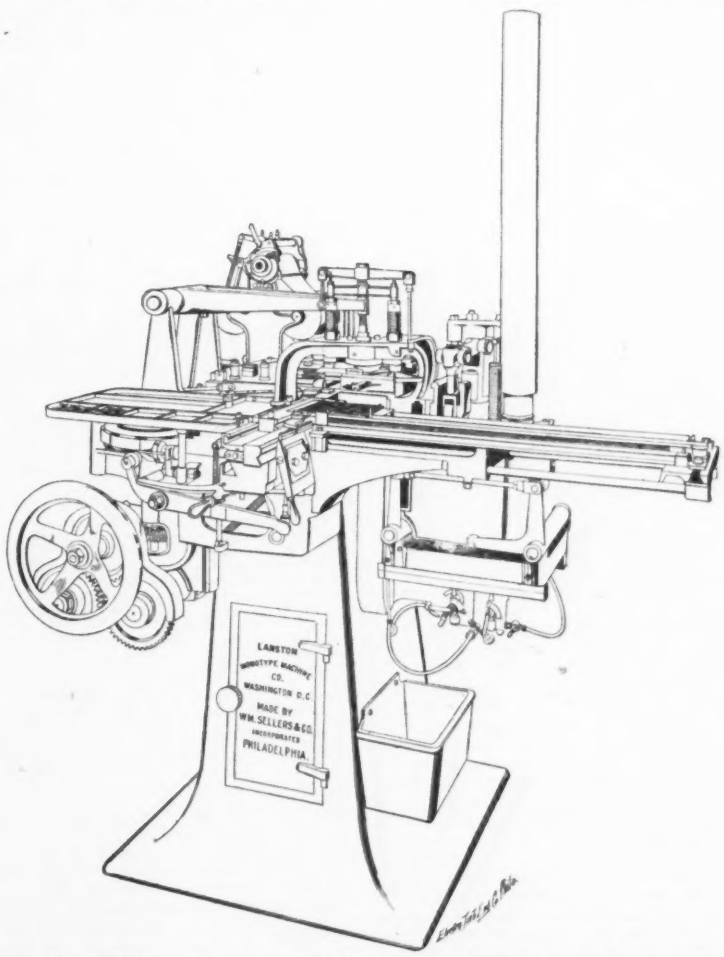


FIG. 3.—FRONT VIEW OF LANSTON TYPESETTING AND CASTING MACHINE.

Fig. 3 is a view of the casting machine, whose operation has just been briefly described. As will be seen the power for operating it is furnished by an electric motor and the operations, once started, are entirely automatic and continuous. Should the operator have made an error at the keyboard in justifying his lines, the casting machine will stop until this error is corrected, but aside from this course it will continue to run indefinitely, except, of course, for stoppages from breakdown, with no further attention than to keep it supplied with material, etc. This means that the rate of composition is entirely independent of the speed of the keyboard operator, since the ribbons may be supplied from more than one keyboard if necessary. Corrections in the galleys are made exactly as with hand-set type, and, in fact, the composed type is to all intents the same as type composed by hand from the case.

Compared with other methods of mechanical or hand composition, that of the machine described presents briefly the following claims made by its inventor. The function of distribution is avoided entirely, there being neither matrices nor types to be returned to their normal position for succeeding use. The paper ribbons may be stored for producing future editions in lieu of type or electrotype or stereotype plates, and no capital is locked up in stored type metal. The fonts of type are readily interchangeable, so that various sizes of types or styles of faces may be substituted for one another in the same machine by a simple operation. The type produced can be distributed in cases for hand composition if desired. The speed of composition is entirely separate from the speed of the operator at the keyboard. By casting only one letter at a time a harder metal can be used, and more perfect and more durable characters produced than can be done with line castings. The measure or the length of the lines can be changed quickly and easily. The maximum travel of any part of the machine in operation is 3 ins. in two directions. The shoulders of the cast type are 20% greater than in ordinary foundry type, which renders possible the production of deeper and better-faced electroplates than is usual with foundry type. The speed at which type can be cast has been found in actual practice to be from 50 to 100 ems per minute, depending upon the size of the type. At the keyboard ordinary good operators can easily average 5,000 ems per hour; an expert

operator has set up 13,000 ems in two hours. The type-casting machine occupies a floor space of only 3 ft. × 3 ft. 8 ins., and the keyboard is but little larger than a large typewriting machine.

The preceding description, with the illustrations, gives a general idea of the character and operation of the Lanston "monotype" typesetting and casting machines. The mechanical details of the machine are not available for publication. This machine is the invention of Mr. Tolbert Lanston, of Washington, D. C., and is handled by the Monotype Machine Syndicate, Ltd., of London, England, and the Lanston Monotype Machine Co., of Washington, D. C. We are indebted to the last-named company for the information from which this article has been prepared.

ELECTRIC MOTORS FOR DRIVING AUXILIARY MACHINERY ON WAR VESSELS.

A good deal has been published in recent years concerning the supposed advantages of driving auxiliary machinery on naval vessels by electric motors. It has been urged that much higher efficiency would result, and consequently saving of coal, while the wires would not be the source of danger, if pierced by a shot, that steam pipes are. The opposite side of this question is taken by Chief Engineer Melville, in his annual report just submitted, and we quote his remarks upon this subject as follows:

For some time past—in fact, ever since the successful use of electric motors for general power purposes on shore—the Bureau has been carefully investigating their adaptability to the driving of the numerous auxiliary engines on board ship, and, in view of the conclusion that the electric drive of the auxiliaries would not, under existing conditions, be so satisfactory and economical, on the whole, as the steam drive, believes it would be of interest to state the reasons for this conclusion.

This is the more appropriate, because in some quarters the fact that electric motors are extensively used on shore has led to the belief that they would be equally successful on board ship. The Bureau has planned to use electric motors exclusively in its new plant at the Brooklyn Navy Yard, and it will be readily appreciated, therefore, that their non-use on board ship is for very good reasons.

The advantages claimed for electric motors over small steam engines on board ship may be classed as greater ease of operation, avoidance of heat, which accompanies the use of steam pipes in living places, and much greater economy. Against these, however, are to be put the much greater weight of the necessary electric outfit, the greater delicacy of the type of electric motors ordinarily used, the lack of ready adaptability to the various conditions of service, a general denial of the claims for economy as ordinarily presented, and the increase in the amount of space required below the protective deck for the installation of the necessary dynamo rooms, this space being necessarily taken from coal bunkers.

On board ship, where excess of weight is so carefully guarded against, it would certainly be very unwise to adopt a change of motive power involving a great increase in weight, unless the advantages gained are very material. It must always be remembered that, speaking generally, on board ship the use of an electric motor involves a total weight for the motive power at least three times that of the motor itself, because there is always the generator and its driving engine, besides the motors supplied by them; or, in other words, the electric drive of an auxiliary will weigh at least three times as much as the steam drive, assuming the motor to weigh no more than the engine it displaces, although usually it does weigh more. The answer which would be made to this is, of course, very familiar to anybody who has studied the problem, viz., that the auxiliaries are not all in use at one time, and that therefore the generator capacity required is considerably less than the total motor capacity. This is another case where a statement which may be true elsewhere is not true for the circumstances on board ship. Our naval machinery has to be designed so that in time of action everything can be ready for use, and, as a matter of fact, a very little study of the question will show that it not only may but almost certainly would happen that every auxiliary on the ship, except the capstan engine and some of the boat winches, would be used simultaneously.

I wish to emphasize the point that the objection to using electric motors for driving the auxiliaries on board ship is not an objection to the use of electric motors per se, but to installing them in a location for which they are not adapted, and where their good features cannot be utilized. What has led to the wide use of electric motors on shore is not only the absence of heat, cleanliness and ease of installation and operation, but, above all, the simplicity of the transmission of power from a central station to a distance. Now the great majority of auxiliaries on board ship are so near the boilers that less piping is involved in a direct steam drive than in an electric drive from dynamos necessarily at some distance from the boilers.

The ease of transmitting power to a distance over a wire, as compared with great lengths of steam piping, gives the electric drive a very attractive side, even for distances no greater than the maximum ones on board ship, so that we should naturally expect to find electrically driven capstans and steering engines. These two auxiliaries are not under this Bureau, but are the ones requiring long and objectionable steam pipes through the living spaces. Here, however, another point has been made by some who are very anxious to use motors elsewhere, viz., that for the service in these cases motors are not sufficiently reliable. Naturally a system involving four parts, each liable to break down, is more delicate than one involving but two of these parts. With a steam drive there are the boilers and the steam engine driving the auxiliaries. In the electric drive we have the boilers, the steam engines and also the electric generators and motors. It is merely a detail whether the steam engines operate the auxiliaries directly or whether a smaller number of them, having a greater power in each engine, operate electric dynamos. Personally I should think, however, that if motors are considered sufficiently reliable to drive feed pumps and air pumps on ship board, for which they are not well adapted, they would be reliable for these other two cases noted, which they fit so well otherwise. The absurdity of an electric drive of auxiliary machinery on board ship situated closer to the main engines than the engines driving the dynamos becomes all the more apparent when contrasted with the steam drive for auxiliaries situated in the very extreme ends of the ship.

On the battleship "Alabama" the space required for electric motors, where used, is approximately the same as that required for steam engines to do the same work. The space required for the wiring, etc., is less than that necessary for steam piping, had that been used. The space required for the generating sets is 10,140 cu. ft. The capacity of these generating sets is 256 K-W. total. If all the auxiliary machinery on board this ship were operated by electricity, and if the space required for the electric generators were increased in the ratio of the increase of necessary capacity in the generating room, the space that would be required in the generating rooms would be 50,700 cu. ft. for a capacity of 1,280 K-W. Consequent upon the extension of the use of electricity would be an increase in the total weight of the machinery equal to from 150 to 250 tons as a minimum. This loss in weight is as much as the gain following the use of water-tube boilers. The increased space occupied by the larger generating rooms would accommodate 900 tons of coal, or 3,600 HP. could be added to the power of the propelling engines, giving the ship in the first instance 45% greater coal endurance, or in the second instance 1.5 knots increase in speed.

NOTES FROM THE ENGINEERING SCHOOLS.

University of Illinois.—The mechanical engineering department announces the following subjects for senior theses now in preparation:

Experiments with compressed air, including a study of the history and development of its uses, with tests of power required, flow of air through pipes and valves, and experiments to determine consumption of air when used as power for hoists and drills; the application of forced draft to boiler furnaces, with the study of several modern types of apparatus as applied to stationary boilers; the design of a 300-HP. plant, with tests of forced draft installations; steam consumption of pumping machinery, with drawings and descriptions of types of pumps and methods of testing and reducing steam consumption; tests of three types of automatic stokers, including drawings and descriptions of three types, with discussion of their advantages and disadvantages, and tests of varying rates of combustion; comparative tests of locomotive injectors, and relative performance of injectors and pumps as boiler feeders; dynamometer car tests, with designs for new apparatus, and records and tables of all tests; the use of compressed air for pumping water, with description and tests of a plant in operation, and tests of various air lifts and pumps; a series of tests with gas and gasoline engines, including special designs for testing apparatus and the determination of the heating power of gas and gasoline, and thermal analysis of heat and expenditure; flow of steam through rectangular openings, and experiments at low and high pressure.

University of California.—Work will shortly be commenced on the new building for the department of engineering and mining. This will be the first addition to be made as a result of Mrs. Hearst's munificent gift to the institution.

University of Michigan.—Mr. Charles F. Brush, M. Am. Inst. Elec. E., has become interested in liquid air experiments, and has ordered two outfits for manufacturing liquid air from a German concern. One of these will be presented to the University, of which Mr. Brush is an alumnus, while the other will go to his Cleveland laboratory.

Chicago School of Assaying.—Courses are offered this year in: Prospecting, fire assaying, ore testing, geology, practical chemistry, qualitative and quantitative analysis, and sanitary and domestic chemistry.

Rose Polytechnic Institute.—Preparations are being made for a series of experiments upon the subject of smoke prevention, to be carried on during the winter.

Cornell University.—The hydraulic laboratory of the College of Civil Engineering has been in use recently in investigations made for the United States Deep Waterways Commission. The experiments were performed under the supervision of Mr. George W. Rafter, M. Am. Soc. C. E., for the Commission, and Prof. Gardiner S. Williams, for the college. These experiments have been directed towards improving the present unsatisfactory methods of ascertaining the discharge of rivers by weir measurements. Some time during the year the laboratory will be opened to students, also to engineers and corporations desiring to conduct experiments not incompatible with the regular work of the laboratory, and without expense to the university.

In his annual report to the trustees, which has just been issued, President Schurman states that the courses in civil engineering and in mechanical engineering are so much in advance of those in other institutions that there are 192 graduates of other schools taking the undergraduate course at Cornell. The overcrowding of class-rooms at Sibley College demands extensive additions to the buildings. President Schurman also reports that the library of Cornell has more than doubled in seven years, containing now 225,022 volumes, and that the use of the library has more than trebled in that time.

Armour Institute of Technology.—A course of study in civil engineering was established in June, 1899, under the direction of Alfred E. Phillips, C. E., Ph. D., formerly Professor of Civil Engineering in Purdue University, Lafayette, Indiana. The Institute now offers courses of study in mechanical, electrical and civil engineering and architecture, as well as a course in science "to meet the wants of persons who, while not caring to take a complete engineering course, may wish to avail themselves of the training and associations of a technical institution."

Particular attention will be given throughout the course, to lectures upon engineering and allied subjects, by men of eminence in the engineering profession, and it is hoped that the engineers in Chicago and vicinity will take advantage of such opportunities to become better acquainted with the institute.

Massachusetts Institute of Technology.—Dr. A. Rambeau, lately of the Johns Hopkins University, has been made Professor of Modern Languages, taking the position made vacant by the death of Prof. Van Daell.

The American Protective Tariff League has announced the award of prizes to Senior students of 1889 for essays on the following subject: "The American Merchant Marine; Its Restoration by Means of Discriminating Duties." The first prize of $150 was awarded to Amasa A. Holden, of the class of '99. This contest was entered by students from Yale, University of Pensylvania, University of Indiana, Knox College, New York University, University of Rochester, Union College and Vassar. It is a notable fact that this prize was won by a technical school.

COKE FROM ILLINOIS COAL is reported as having been successfully made at a cost of $2 per ton, as the result of a series of careful experiments. If this be true, it means fuel for the western iron and steel industries at about half its present cost for Pennsylvania coke.

THE CALUMET & HECLA COPPER MINES, says the "Commercial Bulletin," have a shaft 4,900 ft. deep—the deepest in the world of its size. The lode of copper-bearing rock, from which the largest amount of ore is obtained, is 13 ft. wide, sloping at an angle of 38° to 45°; there are 17 shafts in all on this vein, besides 5 shafts on the Osceola vein, now belonging to the Calumet & Hecla Co. The deep Whiting shaft referred to has a daily output of 5,000 tons of ore running 3½% pure copper, as the ore comes out, and averaging 67% as it is forwarded to the smelters. At this shaft are two 2,000-HP. hoisting engines and a 7,000-HP. plant used solely for pumping air into the company's several mines. This latter engine

forces into the mines 100,000 cu. ft. of air per minute. The company uses about 40,000,000 ft. B. M. of bracing timber in these mines annually. At the present time about 6,700 men are employed, with a monthly cash payroll of $325,000. The output of these mines is not officially reported, but good authority places it at 100,000,000 lbs. of pure copper for the last year. To prevent hostile labor demonstrations, the policy of the company is to employ men of different nationalities, and the present force of 6,700 men is about equally divided among Hungarians, Italians and Swedes.

NO ARMOR FOR THE NEW WARSHIPS can be had at the price fixed by Congress, or $400 per ton. According to the report of Rear-Admiral Chas. O'Neill, Chief of Ordnance, the seven vessels authorized by Act of Congress, and approved May 4, 1898, will require 24,000 tons of armor, for which only one firm bid, at $450 per ton, in recent proposals opened. This bidder had no plant, and his bid was rejected. To avoid delay in the completion of certain vessels the Department contracted for 2,268 tons of armor for the four monitors and vessels of the "Maine" class; but the remainder should be contracted for by Jan. 1, 1900, and Congress must act; otherwise the building of armored ships must stop. A new navy gun is ready to test. This is a 14-pdr. 3-in. rapid-fire intended for the armament of the new destroyers. It is calculated that the projectile from this gun will penetrate over 1½ ins. of Harveyized steel at 3,000 yds.

THE RUSSIAN CRUISER "VARIAG," built by the Cramps at Philadelphia, and ready for launching, is intended to have a speed of 23 knots for 12 hours. The ship is 400 ft. long, 52 ft. beam, 19½ ft. draft, and 6,500 tons displacement. Two vertical inverted triple expansion engines of 26,000 HP. will drive twin screws, and steam is furnished by water-tube boilers of the Niclausse type. The main battery will include 12 6-in. rapid-fire guns, and her secondary battery covers 12 75-mm. and 6 47-mm. rapid-fire guns. She will carry a crew of 21 officers and 550 men.

THE NAVAL BOARD ON CONSTRUCTION has adopted tentative plans for three new battleships and three fast armored cruisers. The first are to be about 13,500 tons displacement and have 19 knots speed, according to the current reports. The superimposed turrets seem to have been adopted, though those of the "Kearsarge" have not yet been tested by actual gun fire. The argument advanced is that this arrangement permits greater concentration of gun power. Instead of two 13-in., two 12-in. new pattern guns will be mounted, with two 8-in. new pattern guns in the upper turret; four 8-in. guns in two turrets amidship are added, and 12 6-in. quick-fire complete the broadside batteries. The armor belt will be 9 ins., tapering to 4½ ins. The cruisers will have 22 knots speed, operated by 23,000 HP.; have double the sailing radius of the "New York"; twin 8-in. guns in turrets and 16 5-in. rapid-fire in broadside. The protective deck will be 3 ins. thick on the flat and 4 ins. on slopes. These plans are severely criticised as being inferior to the latest foreign warships. Chief Melville wanted 23 knots speed in the cruisers and triple screws, but he was voted down; and the superimposed turret is yet an untried expedient.

THE NORTH-GERMAN LLOYD STEAMER "Kaiser Wilhelm der Grosse" lately lowered the record from Cherbourg to New York to 5 days 17 hours 48 minutes; the best previous record—made by the same ship—was 5 days 18 hours 15 minutes. In the last record 3,017 knots were traveled at an average speed of 22.14 knots.

"LA LORRAINE," of the French Line, sailing between Havre and New York, has been launched at St. Nazaire. This steamship is 571 ft. 3 ins. long over all; 50 ft. 2 ins. beam; 39 ft. deep from main deck to keel; 25 ft. 1 in. draft, and her displacement is 15,200 tons. Two triple-expansion engines are expected to develop 22,000 I. HP., and the contract speed is 22 knost. There will be accommodations for three kinds of first-class passengers; 59 "grand luxe," 59 "luxe" and 378 "ordinary" first-class; she will also carry 118 second-class passengers and provisions are made for 398 emigrants, or a total, with crew, of 1,325 persons.

THE NEW ISTHMIAN CANAL COMMISSION is preparing to leave for Panama in December. The members of the committee sent to Paris to investigate the records and surveys of the French Panama Canal Co. have all returned to this country. Advance parties are now at work on the Isthmus, and a party to examine the routes below Panama will be despatched soon. The commission is to make a personal inspection of all the routes, including all suggested. It will probably return next March.

TREE AND SHRUB PLANTING ALONG THE SUEZ Canal is in progress to protect the canal from drifting sand, according to the July bulletin of the "Societe Internationale d'Agriculture." Previous trials with fascines, sand fences, etc., have failed, and in 1896 the canal company began the planting of living plants. Reeds have been planted along 8.7 miles of the water line of the canal proper, and along the whole length of the Sweetwater Canal; these reeds are at first protected against the violence of the bank eddies caused by passing ships by fascines. On the slopes and top of the banks of the Sweetwater Canal plantations of shrubbery have been set out; the Alfa and Atriplex Lalimus being chiefly used. Upon part of the ship canal and along 19 miles of the Sweetwater Canal plantations of trees have been set out extending back about 328 ft. from the water line; these trees are intended as a screen to check the advance of sand from the desert; among the trees planted are the Eucalyptus and Cypress. A system of irrigation by fresh water has been organized for these plantations, the water coming from the Nile by the canals excavated when the ship canal was being built. So far the results are encouraging.

THE RUSSIAN DREDGE, built by the Cockerill Co., of Belgium, on the Bates patents, has been tested on a bar in the River Scheldt, near Antwerp, says U. S. Consul-General Geo. F. Lincoln, of Antwerp. This dredge is built for use on the Volga, and is constructed in two parts so as to pass the Marie Canal system leading from the Baltic. Each half is 216 ft. long by 31½ ft. wide and 9 ft. deep, with 4 ft. 8 ins. working draft; and each half can be operated separately, or, make a bottom cut of 62 ft. wide. The dredge has steel hulls; is propelled and controlled by electricity, installed by the General Electric Co., of New York; a vertical marine type, triple expansion engine generates electrical power, and a pair of horizontal tandem compound engines drive the cutters. Steam is furnished by Babcock & Wilcox marine boilers fired with naphtha. Each main pump engine, of the vertical triple expansion type, develops 1,500 I. HP., running the centrifugal pump at 150 to 180 revolutions per minute. The pontoons carrying the 33-in. discharge pipe are each 50 ft. long, with an elliptical cross section, 9 ft. 3 ins. wide on the horizontal, and 3 ft. 3 ins. high vertically. The couplings are of the ball and socket type, permitting a curvature of a semicircle in a 1,000-ft. line of pipe. The pipe joints are packed by a pneumatic rubber tube, laid in an annular recess in the joint-socket and bearing on the spherical surface of the ball, and inflated by a foot-pump. In an unofficial trial at Drygoten, Belgium, the cutters controlled a stratum 7 ft. thick; and on a cut 2 ft. 4 ins. deep the record was as follows: Distance run, 1,200 ft.; time, 76 minutes; advance per minute, 15.8 ft.; rate per hour, 2,590 cu. yds. The material was a fine compact sand and clay. The official Russian test, with higher steam power, was made parallel to this for a distance of 1,000 ft., and an average cut of 2.44 ft. deep. The time was 37⅓ minutes; advance per minute, 26.8 ft., and rate per hour, 4,524 cu. yds. The trial on the Scheldt, in very fine sand with some hard-packed material, resulted as follows: Distance, 2,129 ft.; time, 180 minutes; advance per minute, 11.8 ft.; average cut, 3.5 ft., rate per hour 2,860 cu. yds. In this trial it was noted that in the hard-faced material the cutters were not powered sufficiently high to supply the full capacity of the pumps. All these tests were made with 700 ft. of discharge pipe, and all measurements were in excavation, determined by soundings.

THE DISMAL SWAMP CANAL, lately improved and now opened to traffic, was commenced in 1787, and was built by Virginia and North Carolina at a cost of $1,151,000. Before being improved it had five locks, averaging about 18 ft. wide by 100 ft. long, and the summit level was 20 ft. above mean tide in the Elizabeth River. The canal originally only connected Deep Creek, emptying into the Elizabeth River, with a tributary of the Pasquotank River; but to this the so-called Gilmerton Level and Turner's Cut were added later. In the new canal there is now only one level, 22.15 miles long, from Deep Creek to South Mills, with two terminal locks, each 40 ft. wide and 250 ft. long. The depth throughout is 10 ft.; the bottom width is 40 ft.; surface width, 60 ft.; with turnouts every 2 miles 100 ft. wide. The summit level has been lowered 8 ft., or to 12 ft. above mean tide; and this fact solves the problem of draining the larger part of the Dismal Swamp, as lateral ditches leading back into the swamp will bring all of the swamp west of the canal under cultivation. This swamp embraces about 1,000 sq. miles in Virginia and North Carolina, and it is covered with a thick growth of timber, chiefly juniper and cypress. Lake Drummond, in the center of the swamp, is about 3 miles long by 2 miles wide, with its surface 22 ft. above tide at Deep Creek, 10 miles away. A feeder, 40 ft. wide and 3½ miles long, leads from the lake to the canal, with a regulating lock near the lake. The swamp land already reclaimed is exceedingly fertile, and the district is very healthy and the water is potable.

THE SALE OF NEW YORK STATE LAND under water, so common in the past, is receiving the attention of Governor Roosevelt and the Land Board, and a committee of this board is now considering the policy of the board in connection with further public applications for grants of land under water. Secretary of State, John T. McDonough, has persistently taken the position that such land should not be permanently alienated by sale, but should be leased for a term of say 25 years, and then reappraised for further lease. In this way the state, and not individuals, would benefit by the inevitable increment in the value of land under water contiguous to our great cities. The true remedy is an act of legislature abolishing such sales; but this has been tried and so far private interests seem powerful enough to prevent its passage. The merits of the case for the state, are well set forth in the late application of the Astoria Light, Heat & Power Co. for a grant of 14 acres of land under water at Berrian Island on the East River. This land has been appraised at $250 per acre, and at this price the state is asked to part with it forever. It is this application that has called for the appointment of the committee mentioned.

THE BOMBAY IMPROVEMENTS, proposed as a means of reducing danger from the plague, include the transformation of the crowded parts of the city by laying out a network of wide streets, and rearranging the houses so as to give more light and air. By the plan proposed, every block of buildings will front on a street and have a well ventilated interior courtyard. The population will be so distributed as to give a maximum density of 500 people per acre. In this connection, the "Indian Engineer" says that the problem of controlling this density in the future is not yet solved. It remarks, however, that 500 is not excessive under conditions prevailing in Europe, whatever it may be in the hot climate of Bombay. For example, the reports on the Peabody Trust Buildings in London, for 1898, show a mean population of 19,562, or a mean density of 714 persons per acre; yet the birth rate in that district was 33.1 per 1,000 as compared with an average of 29.5 per 1,000 for London proper, and the death rate was 14.7 per 1,000 as compared with 18.7 per 1,000 in all London. The difference in these figures is caused by the better manner in which the people of the Peabody buildings are housed, and by the strict supervision over all sanitary conditions.

THE RAISING OF THE COURTHOUSE of Sangamon county, at Springfield, Ill., is now in progress. The building was erected in 1862, and was formerly the State House of Illinois. It is 90 × 124 ft. in plan, two stories high, with massive fluted columns on two sides supporting pediments, while in the center is a cupola. The weight is about 700 tons, and the building has been raised 11 ft. by means of 2,000 screw jacks, the pressure being taken by I-beams let in under the walls. Timber cribbing was built up as the building was raised. Work was commenced on July 1. A new basement will be built, and when the building is supported on its new base, the roof and upper portion will be removed, and a new story will be added on top, so that the old portion will be sandwiched in between a new basement and new top story. The work of raising the building was done by H. Sheeler, 115 Dearborn St., Chicago; and the new portions will be built by Warren Roberts & Co., Unity Building, Chicago.

BOOK REVIEWS.

ESSAIS DES HUILLES ESSENTIELLES.—Par Henri Labbé, Ingenieur-Chimiste, Encyclopedie Scientifique des Aide-Memoire. Paris: Gauthier-Villars. Paper; 7½ × 4½ ins.; pp. 188; illustrated. Paper, 2½ francs; board, 3 francs.

This work is devoted to describing the various methods by which the essential oils, or "essences" of commerce, are extracted from the leaves, flowers, wood, etc., of plants. The processes themselves—of pressure, distillation, maceration and solution—are minutely described.

ATLAS OF THE GEOLOGY OF THE ASPEN REGION, COLORADO.—By Josiah Edward Spurr; Samuel Franklin Emmons, Geologist in charge. To accompany Monograph XXXI. Department of the Interior, U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C., 1898. Cloth; 21 × 18¾ ins.; 27 colored maps.

These maps are prepared from surveys made in 1893, and are drawn on a scale of 1—62,500, or nearly one mile to the inch; except four special maps, which are on the scale of 1—9,600, or 800 ft. to the inch. They give geological maps and sections of this mining region.

THE WHITE MAIL.—By Cy. Warman. New York: Charles Scribner's Sons. Cloth; 4¾ × 7¼ ins.; pp. 197. $1.25.

This is a sketchily written tale of railway life in the west, in which the hero, who is the son of a section boss, climbs nimbly from the position of a mule driver at a wayside water tank to the President's chair of a prominent railway line, and finally marries the daughter of the largest stockholder. The stockholder's daughter is pretty, the train robberies and Indian fights are exciting without being very dangerous, the "silk-stocking" villain is effectually squelched at the end, and, in fact, everything turns out just as it should in well regulated fiction. With these matters explicitly stated further comment may be omitted.

ELECTRICAL AND MECHANICAL TABLES.—Compiled by Sidney Sprout, E. E. San Francisco: Sprout & Stevens. Flexible covers; 5 × 3 ins.; pp. 200; tables and illustrations.

This hand-book is presented to us by the International Construction Co., of Detroit, Mich., and, as there are

numerous advertisements scattered through the pages, it is apparently being distributed by this company as a trade publication.

The information contained in the book covers a wide field, but many important subjects pertaining to electrical engineering are not mentioned, and the material is poorly arranged. What is given, however, is up-to-date, and much of it is not to be found in any of the other electrical hand-books now on the market. This is especially true of the part relating to electric railways.

BUILDING AND ORNAMENTAL STONES.—By Ernest Robertson Buckley, Ph. D., Assistant Geologist, Wisconsin Geological and Natural History Survey. Pub. Doc. Cloth; 6×9 ins.; pp. 544; illustrated.

In this book the Geological and Natural History Survey of Wisconsin has accomplished a very creditable piece of work which might be imitated with profit by other state geological surveys. A fairly good idea of the scope of the volume is afforded by the chapter headings, which are as follows: Part I.—Chapter 1, Demand and Uses of Building and Ornamental Stone; Chapter 2, Necessary Considerations in the Selection of Stones; Chapter 3, Means of Determining the Value of a Stone for Building and Other Economic Purposes. Part II.—Chapter 1, Brief Geological History of Wisconsin; Chapter 2, Igneous and Metamorphic Rocks; Chapters 3 and 4, Sandstones; Chapters 5 and 6, Limestones; Chapter 7, Areas from which Suitable Stone for Different Uses May be Obtained; Chapter 8, Physical Tests of Wisconsin Stones; Appendix, Composition and Kinds of Stone. The volume contains half-tone illustrations of a large number of buildings and monuments built of Wisconsin stones, views of quarries, geological maps, and several very well-executed plates imitating in color and texture many of the leading building and ornamental stones of the state.

CALCUL DES CANAUX ET AQUEDUCS.—Par Georges Davies, Conducteur au Service des Eaux de Paris, Licencie es-sciences. Paris: Gauthier-Villars, Quai des Grands-Augustins, 55. Paper; 7¾×4⅝ ins.; pp. 180; illustrated. 2½ francs.

This volume of the Encyclopedie Scientifique des Aide-Memoire is devoted to a study of the flow of water in natural or artificial channels, as applied to navigation or irrigation canals, to aqueducts and sewers, and to the improvement of rivers or the installation of hydraulic plants. It commences with a discussion of the old Prony formula of 1804, and passes to those of Eytelwein, Bazin, Gauckler, Ganguillet and Kutter, etc. The second chapter applies these formulas and treats of the general relation between velocity, fall, wetted perimeter and capacity of any two channels; and illustrates these by numerous special examples. The influence of vegetation upon flow, the various sections of channels, and maximum volume and velocity, are also handled in the same chapter. While the first chapter presupposes uniform flow, with constant section and fall, the second chapter takes up the reverse of these conditions, or a varied movement, and applies the differential formulas of Ruhlmaur, Bresse, etc. The work closes with a series of tables of coefficients for the formulas of Bazin, Gauguillet and Kutter, Robert Manning, etc.

THE FIREPROOFING OF STEEL BUILDINGS.—By J. K. Freitag, C. E. New York: John Wiley & Sons. Cloth; 6×9 ins.; pp. 319; illustrated. $2.50.

While questions of fireproofing have been more or less fully treated in several recent books on modern steel skeleton building construction, this is, we believe, the first book to be devoted entirely to the subject. Naturally the manner of handling the matter is considerably more comprehensive than in previous books. On the whole, we can confidently recommended the book as being about as good a treatise on fireproof and fire-protective building construction as it is practicable to make of a work of its size in the present experimental state of the fireproofing art. The following list of the chapter headings gives a fairly good idea of the scope and contents of the book: Fire Protection; Development of Fireproofing Methods and Steel Building Construction; Fires in Fireproof Buildings; Tests of Fireproof Floors; Materials Used in Fire Resisting Construction; Permanency-Corrision; Fire Resisting Design; Terra-Cotta Floors—Girder Protection; Concrete and Composition Floors; Column Fireproofing; Fire Resisting Partitions; Exterior Walls, Spandrels, and Wall Columns; Roofs, Suspended Ceilings, Furring; Equipment for Fire Resistance. The printing, illustrations and general make-up of the book are good. The book has an index.

WHO'S WHO IN AMERICA.—A Biographical Dictionary of Living Men and Women of the United States. 1899-1900. Edited by John W. Leonard. A. N. Marquis & Co., Chicago. Cloth; 7½ × 5¾ ins.; pp. 822; $2.75.

A biographical dictionary dealing with the living only is a unique venture among publications of this character. But for the reason that the greatest number of people are most interested in those still actively at work, this book should be correspondingly welcome and useful. The 8,000 or more names given are designed to include those of some prominence in public life, including especially those of eminence in the professions, although a number of active business men and inventors are included. In its names of well-known engineers the list is particularly complete, and we know of no other publication of this class in which the engineering profession has been so well represented. In the biographical sketches no space is wasted upon irrelevant material, but all the important facts are given, including the very important one of the address of the subject of the sketch at the time of publication. In the case of authors the names of their chief works are noted; and in the case of others a brief sketch is given of their public service of any nature. While many omissions must inevitably occur in so broad a venture as this, the book is still remarkable for what it does contain, and the publishers are to be congratulated upon the result of their labors. It should also be noted that, unlike many other publications of this kind, the only paid matter in this volume is to be found in the dozen or more advertising pages at the back.

BROWN'S DIRECTORY OF AMERICAN GAS COMPANIES.—Compiled and Corrected by E. C. Brown. Eighth Year (1899). New York: Progressive Age. Cloth; 7× 10 ins.; pp. 156. $5.

So far as we know this is the only gas directory published in this country. Under each company it gives, where the information could be obtained, the capital stock, bonds outstanding and rate of interest, names of officers, process of manufacture, number of consumers, population, price of gas for public and private service, consumption per burner per hour and number of hours burned by street lamps, annual output and candle power, proportion sold for fuel purposes and lowest pressure available for gas stoves. Where electric lighting plants are operated conjointly with gas works about the same range of information is given for them. The volume includes a list of parent or operating companies and the officers, members, and dates of meetings of the various gas associations of the country.

There are no summaries, not even a statement of the number of companies included, nor the number having electrical departments; nor does the book enable one to tell with certainty whether any given place has a gas supply, the arrangement being by companies rather than towns, and some companies supplying several places. Thus, neither Bloomfield nor Glen Ridge, N. J., are included, although each is supplied by the Montclair Gas & Water Co., which, in turn, is controlled by the Newark Consolidated Gas Co. However, the volume is really much more than its title implies, and contains a large amount of useful information, for which we should all be thankful, in view of the great lack of statistics relating to municipal affairs.

ELEMENTS OF PRECISE SURVEYING AND GEODESY.—By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. New York: John Wiley & Sons. Cloth; 9 × 6 ins.; pp. 261; illustrated. $2.50.

Prof. Merriman in this work clearly lays down the laws governing precision in surveying and in geodetic and astronomical work; shows the errors to which the processes of computation are liable, and indicates the methods by which these errors may be eliminated, or, at least, reduced to their lowest probable value. It is a book adapted both for class work and for field and office use; and it embodies the latest views upon this important subject, fully set forth and explained. The opening chapter deals with the kind and probability of error, and especially refers to the treatment of accidental errors that remain after all constant errors and mistakes have been investigated and eliminated. These accidental errors are those due to the sudden expansion of bubble or standards, in leveling, to the effect of wind, irregular refraction, imperfections in the human touch and sight, etc. In this chapter the method of least squares plays a large part in determining the most probable values of observed quantities, both in the case of accidental error and in measurements, all made with equal care and having, so-called, equal weight. In succeeding chapters the author deals with precise plane triangulation, and the methods of detecting the probable error and weight of angles and triangles; the principles and methods of base-line measurement and adjustment, spirit leveling, geodetic leveling and leveling by vertical angles, and astronomical observations and the principles governing them. In a separate chapter the early history of spherical geodesy is set forth, from the speculations of the Greek philosophers to the latest principles laid down; and a following chapter on spheroidal geodesy discusses meridian arcs, plumb-line deflections from the normal to the spheroid, length of meridian and parallel arcs, etc. Geodetic co-ordinates and projections are discussed, and then comes the various methods of map projection and schemes whereby succeeding map makers sought to develop a surface of double curvature on a plane without too much distortion, finally settling in the polyconic projection now exclusively used in geodetic work. An exceedingly practical chapter is one relating to geodetic triangulation, with heads covering reconnoissance, stations and towers, signals, horizontal angles, the computation of triangles, figure adjustment, etc. The final chapter discusses the earth as a spheroid, ellipsoid, ovaloid and geoid, the latter designating the actual figure of the surface of the waters of the earth. Briefly stated, this work sets forth the elements of geodetic theory and practice, and gives a history of geodesy, from its first conception of the earth's surface as a plane, to that of a sphere, a spheroid and finally a geoid, an assumption made as late as 1872. But this geoid, as compared with a spheroid of equal volume, has a very irregular surface, rising or falling above or below the compared spheroidal surface, in conformity to the varying intensity and direction of the forces of gravity. Prof. Merriman objects to this figure as being very variable, under the influence of atmospheric disintegration, internal forces, and the changes produced by the conical rotation of the earth's axis around its mean position in its period of about 425 days. For these reasons the author is convinced that the only figure for standard reference in geodetic surveying is the spheroid of revolution, or an ellipsoid with three unequal axes. The book concludes with a series of tables giving mean celestial refraction, lengths of arcs of meridian and parallels; logarithms for geodetic computations, in meters, including the L M Z problem.

THE MINERAL INDUSTRY: Its Statistics, Technology and Trade in the United States and Other Countries to the End of 1898.—Edited by Richard P. Rothwell, Editor of the "Engineering and Mining Journal"; ex-President Am. Inst. M. E.; M. Am. Soc. C. E.; F. R. S. S., London; M. Am. S. A., etc. Vol. VII., supplementing Volumes I. to VI. New York and London: The Scientific Publishing Co. Cloth; 9¼ × 6¼ ins.; pp. 909; illustrated. $5.

Any full review of the hundreds of pages of this important statistical work would consume more space than can be given to it; consequently, little more can be done than to indicate the scope of its treatment. It should be first noted that these volumes supplement each other, as a repetition of the data presented in the earlier editions, and virtually going back to the beginning of the mineral industry in this country, would result in a publication too bulky for convenience. Each volume, however, is practically complete in itself in all that relates to the business features of the industry; all noteworthy changes in metallurgical or chemical processes, or mining methods, are set forth in each; and when these changes are important they are minutely discussed by experts. The editor has had most able assistance, and among the contributors of the material contained in this volume will be found such noted men as Henry M. Howe, Dr. G. M. Dawson, James Douglass, W. P. Blake, Peter S. Gilchrist, Prof. R. H. Richards, etc. Some of these men have presented monographs on special subjects that would each make a respectable volume in itself.

The total value of the mineral production of the United States in 1898 is set down at $709,816,750, as compared with $648,804,899 in 1897. Of the last year's production $314,255,620 was the value of metals, and $433,659,141 that of ores and minerals. This matter is given in tabular form and in descriptive text under the heads of metals and alloys and ores, minerals and chemical products. The method of treatment adopted in this volume is to group together, as nearly as possible, all substances having a common metallic base; so that "Aluminum and Alum," as a chapter head, includes bauxite, corundum, emery, cryolite, metallic aluminum, alum, etc. Without attempting to give all the separate chapter heads, some of the more important contributions under these heads may be noted as follows: The recovery of ammonia and ammonium sulphate from gas liquor, by Hans A. Frasch; and the refining of asphaltum, by the same contributor; the cement industry of the United States in 1898, by F. H. Lewis; the clay industry of Massachusetts, Charles L. Whittle; the principles of firebrick manufacture, Charles Ferry; manufacture and use of paving brick in the Middle West, H. Foster Bain; kaolin, by T. C. Hopkins; coal mining methods and their economic bearings, W. S. Gresley; the occurrence and utilization of peat, E. A. Sjostedt; Canadian coal, G. W. Dawson; the electrolysis and refining of copper, Edward Keller; identification of gems, Leopold Claremont; the gold fields of French Guinea, E. D. Levat; progress in the metallurgy of gold and silver, W. R. Ingalls; progress in gold milling, R. H. Richards; the hydro-metallurgy of silver, Ottokar Hofmann; technology of gypsum, G. P. Grimsley; notes on the progress of iron and steel metallurgy in 1898, Henry M. Howe; manufacture of nickel steel in the United States, Titus Ulke; recent improvements in lead smelting, H. O. Hofman; present practice in silver-lead smelting at Denver and Pueblo, L. S. Austin; lime and lime-burning, H. A. Frasch; geology of the mica deposits in the United States, J. A. Holmes; mica mining in Bengal, India, A. Mervin Smith; the manufacture of acid phosphate of lime, Peter S. Gilchrist; recent practice in the metallurgy of quicksilver in California, R. B. Symington; occurrence and recovery of sodium carbonate in the Great Basin, S. A. Knapp; the building and road stones of Massachusetts, C. L. Whittle; the manufacture of chamber sulphuric acid; F. J. Falding; notes on the metallurgy of tin, Henry Louis; the occurrence and production of wolframite in Arizona, W. P. Blake; zinc and cadmium, W. R. Ingalls; progress in ore dressing in 1898, R. H. Richards; the progress of metallurgy in 1898, Albert Sauveur. Many of these articles are very fully illustrated; and coming, as they do, from men of high professional standing, they are valuable contributions to our knowledge under the heads given. The field here covered is enormous in extent; and while it is beyond human effort to insure accuracy in every detail in treating of such a subject, Mr. Rothwell and his co-laborers are to be congratulated upon presenting to the industrial world such a mass of useful statistical and technical information.